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(71) Applicant *(for all designated States except US)*: TELECOM FINLAND OY [FI/FI]; P.O. Box 106, FIN-00051 Tele (FI).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: SUOMINEN, Antti-Jussi [FI/FI]; Jaalaranta 9 B 39, FIN-00180 Helsinki (FI). MATTILA, Ari-Pekka [FI/FI]; Kukkumäenkuja 12 as, 4, FIN-02280 Espoo (FI). HOLMBERG, Andreas [FI/FI]; Gyldenintie 8 B 37, FIN-00200 Helsinki (FI). TÖHÖNEN, Harri [FI/FI]; Jääkärinkatu 8 A 11, FIN-00150 Helsinki (FI). HALME, Petri [FI/FI]; Sturenkatu 32-34 A 5, FIN-00550 Helsinki (FI). OLLIKAINEN, Jussi [FI/FI]; Vesakkotie 7 A 28, FIN-00630 Helsinki (FI).

(74) Agent: LAHTI, Heikki; Telecom Finland Oy, P.O. Box 106, FIN-00051 Tele (FI).

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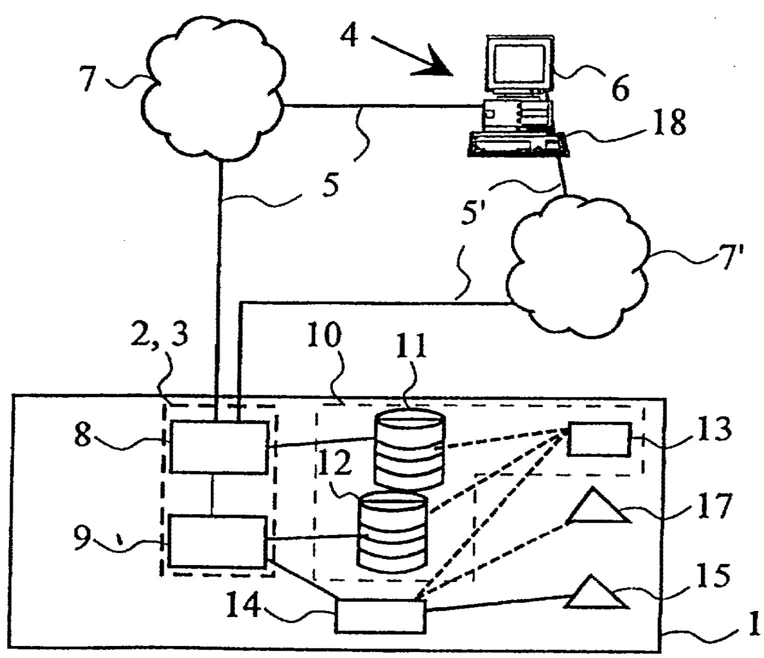
(54) Title: SYSTEM FOR MANAGING SUBSCRIBER RELATED SERVICES WITHIN A TELECOMMUNICATIONS NETWORK

(57) Abstract

The object of the invention is a novel system for changing and/or managing teleservices in the telenetwork. According to the invention with the server assembly controlled by a teleoperator an opportunity is arranged for the subscriber to change and browse for instance through Internet his own subscriber related coupled services. Because of the invention the control of services on one's own initiative by the subscriber's actions becomes easier than before. The invention also reduces and facilitates the work of the teleoperator.



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SYSTEM FOR MANAGING SUBSCRIBER RELATED SERVICES WITHIN A TELECOMMUNICATIONS NETWORK

The present invention relates to a novel system for modifying and/or managing teleservices within a telecommunications network.

Nowadays both in a fixed telephone network and in a mobile telephone network many service varieties are available relating to the possibilities offered by an operator of a wired or a wireless telephone. These services may include a fixed or a remote-controllable call diversion, knocking, blocking of the numerical display, advance noticing of the invoicing to the subscriber and the like. The use of these services is selective from the subscriber's point of view or the subscriber may decide, when he shall utilise each service. It is possible to couple the services for operation at least in two ways or by giving to the operator a commission to couple the service or by calling a certain number, which has a menu to be controlled by the keyboard of the telephone and a guiding voice.

At the present the subscriber may himself perform the control modes of his telecommunication services only in a very limited way through the telephone network (e.g. fixed call diversion programmed by the key combination *21 *... #). In configuration modifications that are even slightly more difficult one must call the teleoperator or service provider and ask him to make the desired change. In control solutions realised with the help of the voice frequency telephone (DTMF) and automatic telephone service systems (APJ) only telephone keys (=1, 2, ..., 0, #, *) and voice guides are available. By them it is difficult to carry out the control modes of complicated services so, that the final result would be ergonomic for the user. When the number of menus increases, the user often "drowns" among the menus and does not know any more (i.e. does not see) in which menu he/she is in any time, when the visual feedback from the location in the menu is lacking.

A further problem is that the teleoperator or service provider must bind resources to the customer service in order to be able to offer to the subscribers flexible control over their services.

The object of the present invention is to eliminate the above-mentioned drawbacks. The object of the present invention is particularly to set forth a novel method and system enabling coupling of the services related to the telephone by the subscriber's own actions. A further object of the invention is to facilitate by a graphical user interface the action of subscribers when selecting and guiding the services.

An object of the invention is further on to improve the possibilities of the customer to decide himself when and with what kind of configuration he wants to use his teleservices. At the same time the work load of the operator's customer service is reduced in simple configuration alterations.

An object of the invention is also to make it possible for a customer by a novel server platform implemented to a telecommunications network to get in contact with the teleservice library or -menu maintained by the teleoperator, and then with the help of a graphical user interface independently edit and control the desired teleservices.

The system according to the invention for managing subscriber related services, as call diversion or knocking by actions of a subscriber, includes according to the invention means for identifying the subscriber and means for forming a graphic or text-based presentation from the subscriber information on the grounds of the subscriber identification. In one preferable embodiment the server comprises a kind of a server platform, including a network server understanding the HTML-protocol, preferably an Internet-server and a changing and/or controlling server understanding also the HTML-protocol. The controlling server is preferably connected to the Internet-server, which is in connection to the teleoperator's database. In one advantageous embodiment the user interface of the changing and/or controlling server comprises a graphic operational connection of www-type. A subscriber register database is also preferably connected with the controlling server. In another advantageous embodiment both the teleoperator's database and the subscriber register database are in connection with the customer database transmitting the customer data to the adaptation server connected with the transforming and/or controlling server of teleservices.

The system includes also a terminal device according to the invention being connected by telecommunication connection, preferably Internet-network, to the server and to which device includes means to give a subscriber-related identification symbol to the server and a display to present subscriber-related information graphically or as text data. The telecommunication connection can be established also for example in the telephone network by a modem. The terminal device may comprise a computer, a portable mobile station or the like, and by it the control data given by the subscriber are transmitted to the server. Then the server relays to the subscriber according to the identification symbol given by the subscriber the menu of subscriber-related services, in which subscriber-related coupled services are presented, and a menu, from which the subscriber selects the service to be coupled.

An advantage of the present invention compared with the prior art is, that it is possible to offer to the user of the teleservice a control solution, by which the subscriber can be coupled to the operator's information systems and alter or check by himself the information included in his services in such a way, that the solution is sufficiently versatile, easy-to-use and economical for the user and on the other hand sufficiently flexible and safe for the operator.

Further because of the invention following advantages are obtained concerning the subscriber. The system according to the invention offers significantly more versatile alternatives to realise control solutions for complicated services including many qualities by the self-service principle, because the subscriber sees the respective configuration of his own services clearly in a visual way. A further advantage of the invention is that the subscriber may decide himself and select, when and what kind of service guiding he is going to use.

Additionally one advantage of the present invention considered from the operator's point of view is that there is no problem concerning the distribution and/or updating of the customer application, because this application is updated automatically for all users, when the operator updates the information of the concentrated server and the service routines integrated into it. Additionally because of the invention all the system components requiring the maintenance are in the operator's and service provider's own network and control. Thus also the service assortment visible to the subscriber can flexibly be altered.

Further on due to the invention the operator's work load is reduced in routine simple operations and the system is available from anywhere in the world through Internet. Additionally several services can flexibly be connected to the system and it can also be used as a marketing and advertising channel for new teleservices.

In the following the invention will be described with the help of enclosed performance examples with reference to the accompanying drawing, in which

figure 1 shows one system according to the present invention;

figure 2 shows diagrammatic plan of the operation of the system according to the invention; and

figure 3 shows as an example one graphical user interface according to the invention.

The system shown in Fig. 1 includes a computer 4 comprising the display 6 and the keyboard 18. The system comprises further the server platform 1, including the network server 8 and the control server 9. The computer 4 is associated through a telecommunication connection 5, 5' to the server 1. The telecommunication connection can be established to the Internet-network 7 or to any other corresponding network 7' transmitting the data. The server assembly 1 has been established advantageously by two server computers, of which one serves as a usual network server understanding the HTML-protocol for example in the Internet-network, and the other is also a control server understanding the HTML-protocol. In the computers 8, 9 suitable software 2, 3 has been arranged, by which the subscriber identification is established, when the subscriber is entering at the system, a graphic presentation is made for the services coupled to the subscriber and a service menu, from which the subscriber may couple for himself extra services. Such a graphic presentation comprises generally a WWW-page.

The system shown in Fig. 1 includes also database means 10, with which the teleoperator's database 11, the subscriber register database 12 and the customer database 13 are maintained. The database means are connected to the server 1, whereby it is possible to obtain subscriber-related information from the databases and the services coupled by the subscriber can be updated to them under the control of the server. In Fig. 1 it is shown an application server 15, which is coupled between the telephone network and the Internet-network. In Fig. 1 it is also set forth a service network element 17, with which an external service provider may connect his own service to the system.

In the following it is presented with reference to figure 2 and figure 3, in which one exemplary graphical user interface 16 is shown, one example of the subscriber's login procedure. In Fig. 2 in the block 19 the teleoperator's home page in Internet is described. From this home page the subscriber gets the connection to other WWW-services, block 21, and to the system according to the invention, block 20. In this way the subscriber may select a link from any start page to the system in question 20. According to the invention it is possible to connect different subscribers, as private and business customers, to the system. Different customers are described by the blocks shown by the arrow 22. The customer enters to the system in the block 24 and in association with the login the system checks the subscriber information from different databases. After the login, block 23, a subscriber-related service menu 16 is opened to the subscriber, which menu is shown in Fig. 3. The service menu 16 may include different kinds of optional services, blocks 25 - 31. In one example by selecting one block 25 - 31 and accepting the selection the subscriber may couple the service in question on or off depending the service status at that time. Based on this the control server 9 updates databases according to the need.

It is also pointed out that Internet is by no means the only possible operational environment, but that any other telecommunication network system is valid. It is not either required that a WWW- user interface compatible with the IP-protocol will necessarily be used as a graphical user interface, but any other graphical user interface, e.g. MS-WINDOWS, is valid for realising the principal idea of the present invention. It should be observed that it is possible to use a traditional text-based user interface to be offered via the terminal connection.

As a conclusion about the invention it is possible to state as follows. By the invention following problems will be solved. Firstly the user identification can automatically be made in association with the login. Further on the system according to the invention offers a user-related and dynamically changing graphical interface that the teleoperator may control. The subscriber is also connected by the user identifier to the information used by the telephone network and only limited operations are permitted and only limited information is presented to the user. The limitation can be made relating to the subscriber based on the user identification. Further on the access of the user to the information of other users is prevented in the system.

The invention is not limited only to the embodiment examples presented above, but many modifications are possible while staying within the inventive idea defined in the accompanying claims.

CLAIMS

1. A system for managing telephone network's subscriber related services, as call diversion, knocking and the like by actions of the subscriber, c h a r a c t e r i z e d in that the system includes:

a server (1), including means (2) for a subscriber identification and means (3) for establishing a graphic or text-based presentation from the subscriber-related information on the grounds of the subscriber identification; and

a terminal device (4), which is connected by a telecommunication connection (5) to the server and have means (18) for giving the subscriber related identification to the server and a display (6) for the presentation of the subscriber related information graphically or as text data in order to transmit the control information given by the subscriber to the server,

whereby the server transmits to the subscriber according to the identifier given by the subscriber a menu of subscriber related services, in which are presented the subscriber related coupled services, and a menu, from which the subscriber selects the service to be coupled.

2. A system according to claim 1, c h a r a c t e r i z e d in that the server (1) is realised in a telecommunication network (7); and that the server includes:

a network server (8) for establishing a telecommunication connection (5) to the telecommunication network and through this to the terminal device (4); and

a control server (9), which is connected to the network server for controlling subscriber related services in the telephone network, and to which has been arranged a graphical user interface.

3. A system according to claims 1 or 2, c h a r a c t e r i z e d in that the system includes database means (10) for maintaining teleoperator's database

(11), subscriber register database (12) and customer database (13).

4. A system according to any of the preceding claims 1 - 3, c h a r a c t e r i z e d in that the system includes an application server (14), which is arranged to combine together the telephone network and the telecommunication network (7).

5. A system according to claim 4, c h a r a c t e r i z e d in that the system includes a service network element (15) for coupling the services of a service provider to the system.

6. A system according to any of the preceding claims 1 - 5, c h a r a c t e r i z e d in that the graphical user interface includes a subscriber-related service menu (16).

7. A system according to any of the preceding claims 1 - 6, c h a r a c t e r i z e d in that the system includes a teleservice library (17), to which has been deposited the information concerning the service provided in the telephone network, and which is maintained by the teleoperator and/or the service provider; and that a connection is arranged from the server (1) to the teleservice library.

8. A system according to any of the preceding claims 1 - 7, c h a r a c t e r i z e d in that the telecommunication connection between the server (1) and the terminal device (5) has been established by a HTML-protocol.

9. A system according to any of the preceding claims 1 - 8, c h a r a c t e r i z e d in that the telecommunication network comprises the Internet-network or the like.

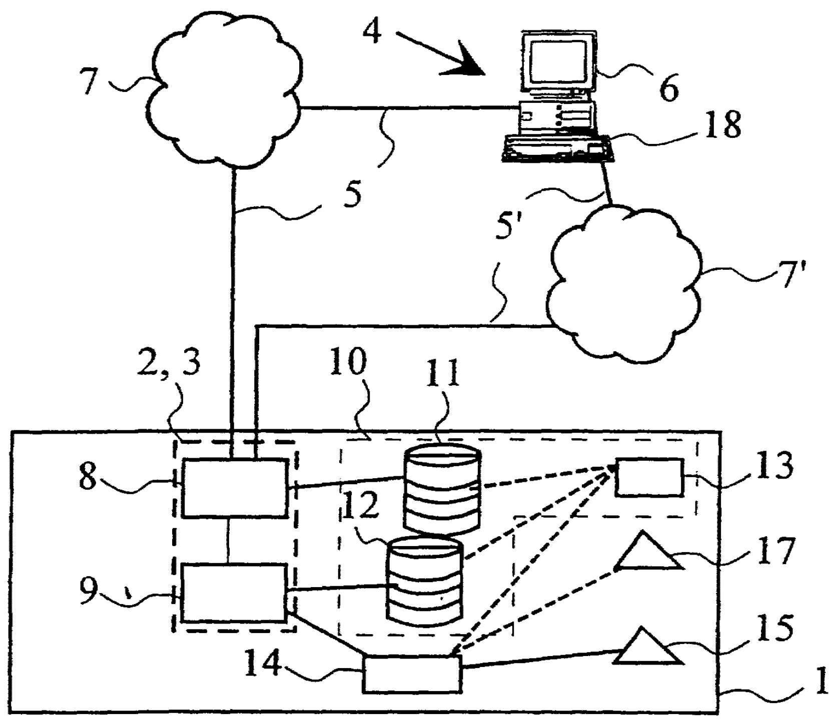


Fig 1

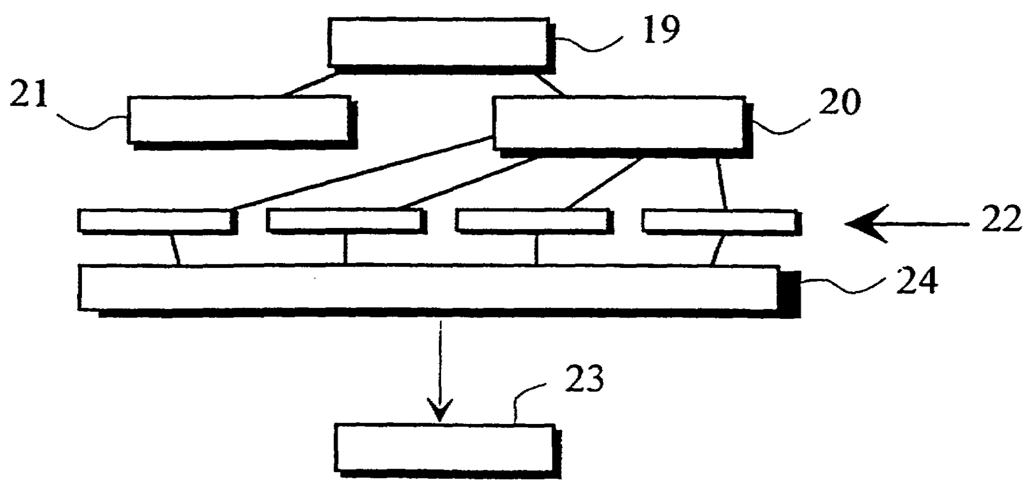


Fig 2

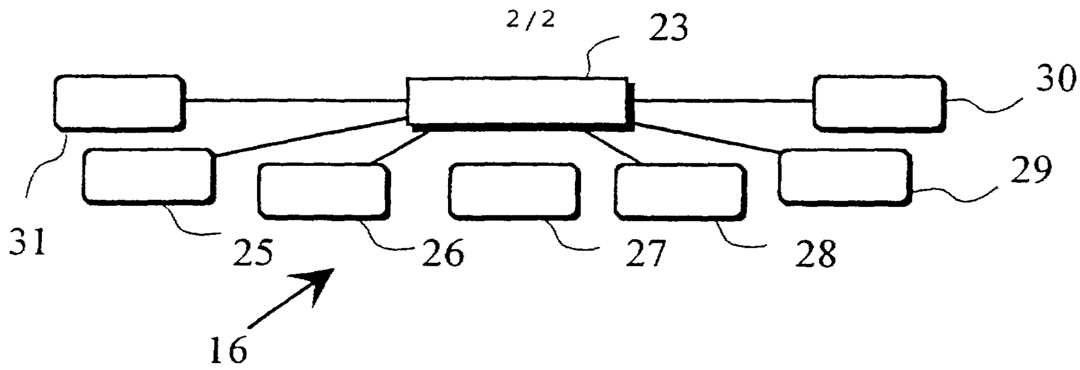


Fig 3

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 97/00299

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC6: H04M 3/42

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| A | US 5241588 A (BABSON, III ET AL), 31 August 1993 (31.08.93)<br>-- | 1-9 |
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(71) Applicant: ERICSSON INC. [US/US]; 7001 Development Drive, P.O. Box 13969, Research Triangle Park, NC 27709 (US).

(72) Inventors: BOLTZ, David; 901 Loch Ness Lane, Garland, TX 75044 (US). MAUPIN, Alain, Guy; 1133 Lookout Drive, Richardson, TX 75080 (US). MAO, Xiaohong; 2400 Waterview Parkway #424, Richardson, TX 75080 (US).

(74) Agents: MOORE, Stanley, R. et al.; Jenkens & Gilchrist, P.C., Suite 3200, 1445 Ross Avenue, Dallas, TX 75202 (US).



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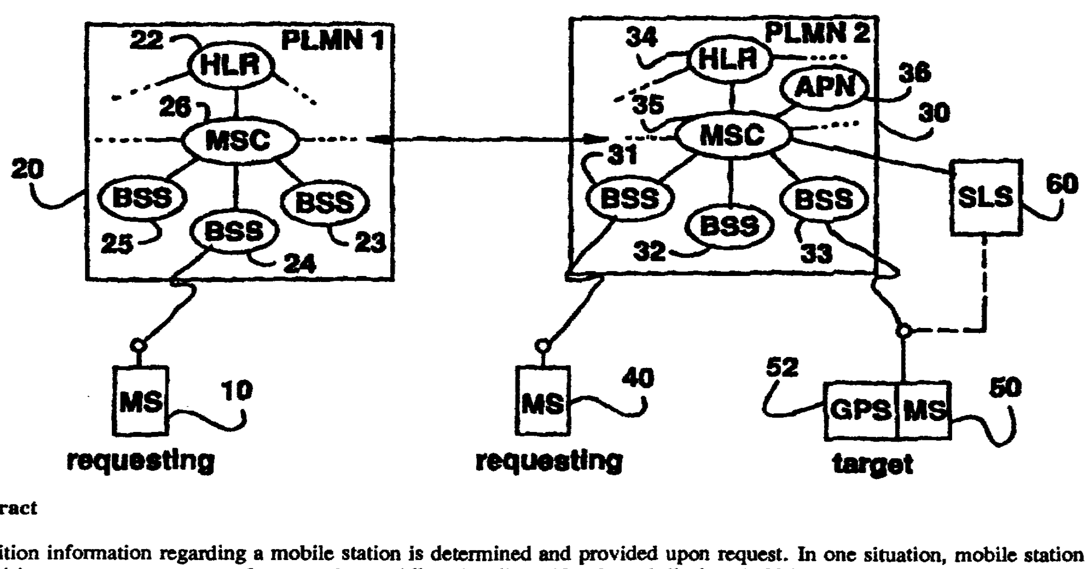
(54) Title: METHOD AND APPARATUS FOR COMMUNICATING INFORMATION ON MOBILE STATION POSITION WITHIN A CELLULAR TELEPHONE NETWORK





(57) Abstract

Position information regarding a mobile station is determined and provided upon request. In one situation, mobile station position is determined in response to a request from another mobile subscriber (10, 40) and displayed (226) on the requesting mobile station display. Mobile station position is also determined in response to a request from a land line user (70) and provided through either a synthesized voice communication (233), a data message (225) or a facsimile message (237). Mobile station positions are further provided in response to law enforcement (320) and other public service entity (422) requests. This information is useful in tracking a mobile station (312, 412) either during a call or when the mobile station is idle. In another instance mobile station location information is used to insure routing (434) of emergency (911) calls (424) to the proper public safety answering point (422). The system further has the capability of being programmed with certain response criteria applicable to the determination of mobile station position. Such criteria include accuracies, confidence factors, periods between location reports, and location determination technique.

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# METHOD AND APPARATUS FOR COMMUNICATING INFORMATION ON MOBILE STATION POSITION WITHIN A CELLULAR TELEPHONE NETWORK

## BACKGROUND OF THE INVENTION

### Technical Field of the Invention

The present invention relates to locating the geographic position of a mobile station operating within a cellular telephone network and, in particular, to the provision of the determined geographic position information in response to requests from, for example, other subscribers and public service agencies, and further to the use of mobile station location information to direct the routing of emergency cellular telephone calls and the rendering of emergency assistance.

### Description of Related Art

Cellular telephone networks typically include a plurality of base stations connected to a centrally-located switch commonly referred to as a mobile switching center. Base stations may be spaced apart from each other by distances of between one-half and twenty kilometers. Each base station is assigned a number of two-way voice channels and control channels. The voice channels are used to transmit voice signals to and from proximately located mobile stations. The control channels are used for the transmission of control information to and from those mobile stations, usually for the purpose of establishing a voice communications link.

The control channels used for transmissions from a base station to a mobile station are called the "forward" control channels. The forward control channel is generally a common channel, which means that any mobile station may access the channel and listen for messages transmitted by the base station. Conversely, the control channels used for transmissions from the mobile station to the base station are referred to as "reverse" control channels. The reverse control channels may be common, in which case there may be contention for access, or may be dedicated, which means that they are reserved or assigned for the use of a single mobile station in making a transmission to a base station.

Cellular telephone networks typically include a plurality of interconnected mobile switching centers, including a gateway mobile switching center through which the network interconnects with the conventional public switched telephone network. At least one home location register is included within a cellular telephone network. The home location register is used to store subscriber information including an identification of current mobile station location within the network.

In response to an incoming call dialed to a given mobile station, a signal is sent to the home location register requesting routing information through the network to the called mobile station. The home location register looks up the current location of the mobile station and contacts the currently serving mobile switching center to pre-route the call and retrieve a temporarily location directory number which is used to route the call through the network for delivery to the mobile station. The serving mobile switching center retrieves from a visitor location register an identification of the cell within which the called mobile station is currently located. The mobile switching center then instructs the base station associated with that cell to page the mobile station. Responding to the page, the mobile station requests assignment of a channel, and the network routes the call through the serving mobile switching center and over the assigned channel.

Conventional cellular telephone technology, by itself, does not include the capability of pinpointing, with any reasonable or useful degree of accuracy, the location of the mobile subscriber. For example, using a conventional cellular telephone network, the extent of the location precision typically available is to identify the cell within which a mobile station is located. Some cells, though, have a coverage radius in excess of one kilometer. Thus, cell location identification accordingly provides little, if any, assistance in actually locating the position of the subscriber. Accordingly, a number of systems have been proposed to assist in the location determination and provide more accurate position information. One system utilizes a triangulation or arcuation process to determine an approximate location of the caller through an analysis of signal strength measurements and/or propagation delay times of the cellular communications. Another system utilizes the existing Global Positioning System (GPS) with a GPS receiver attached to the cellular telephone to obtain geo-coordinates for the mobile station.

Although many systems have been proposed for more precisely identifying the location of a mobile station, it is equally important that the determined position information be provided to the persons or entities who need the information. Take first, for example, the cellular subscriber himself. It is not unusual for the subscriber to get lost and realize that they need to know their precise location in order to obtain directions. Absent the presence of landmarks or other location indicia (like street signs), the subscriber has no way of identifying their location without asking for help. In certain situations, like in rural areas, such help may not be available. It would be an advantage then if the cellular subscriber could use his or her mobile station to signal the cellular telephone network to make a position determination and relay that information to the subscriber for subsequent use in calling for directions.

In another example, consider the person who desires to know the location of a cellular subscribing family member or friend. The family member or friend may be late for an appointment and the person becomes concerned that they may be lost, injured or otherwise in need of assistance. Alternatively, the person may suspect that the family member is engaging in an undesirable activity and wish to monitor their location. In any case, it would be an advantage if that person could signal the cellular telephone network to make a position determination on a particular mobile station and relay that information back to the person for evaluation.

In yet another example, consider the situation where a law enforcement agency desires to know the location of either a mobile station or the person using the mobile station. Thus, for a mobile station located in a stolen vehicle, the law enforcement agency would want to monitor the location of the mobile station, and hence the stolen vehicle itself, to assist in apprehending the thief. Alternatively, a law enforcement agency may have an interest in monitoring not only the cellular telephone communications made by a cellular service subscripting suspect, but also the locations from which those calls are occurring. It would be an advantage, then, if the law enforcement agency could signal the cellular telephone network to make a position determination on a particular mobile station and relay that information back for use in tracking the suspect.

Cellular subscribers now frequently use their mobile stations to make emergency (911) calls. Unlike conventional land line telephones, mobile stations have no fixed address relating to a location which may be obtained by the public safety answering point (PSAP) when an emergency call is made. Accordingly, it would be an advantage, then, if the public safety answering point could signal the cellular telephone network to make a position determination on a particular mobile station from which an emergency call originates and relay that information back for use in dispatching emergency service aid.

Furthermore, knowing the location of the mobile station does not comprise the only concern in rendering emergency services in response to a cellular emergency call. It is also important that the emergency cellular call be routed through the network to the proper public safety answering point in those instances where the calling mobile station is roaming. In such cases, it would be an advantage if a switch handling the call could request location information on a particular roaming mobile station from which an emergency call is originated and use that information in determining which public safety answering point is the correct public safety answering point (based on proximity to the mobile station) to handle the call and dispatch the emergency service aid. It would further be an advantage if position information could be determined in response to that same request and provided to the correct public safety answering point for use in directing emergency services personnel to the aid of the subscriber.

## SUMMARY OF THE INVENTION

The present invention comprises a system for selectively conveying mobile station position information to requesting entities. In a first embodiment, the system responds to a position request from another mobile station by routing the request to the serving switching node, processing location information to determine a mobile station position, and routing a return message identifying the determined position to the requesting mobile station. In another embodiment, the system responds to a position request from a land line telephone user by routing the request to the serving switching node, processing location information to determine a mobile station position, and routing a return message identifying the determined position to the requesting user for presentation in either a synthesized oral manner, as a data message, or as a facsimile message. In another embodiment, the requesting entity comprises a public service entity such as a law enforcement agency, and the system responds to a position

request by routing the request to the serving base station controller, processing location information to determine a mobile station position, and routing a return message identifying the determined position to the requesting entity.

The present invention still further comprises a system for determining mobile station location, and processing location information to identify a proper public safety answering point to which an emergency call from that mobile station should be routed. In connection therewith, an anchor exchange recognizes that the mobile station is roaming and wants to place an emergency call, and requests from the serving exchange an identification of the mobile station location. This information is then used to route the call to the proper public safety answering point. Furthermore, either the anchor exchange or the public safety answering point to which the emergency call is routed may then make a request for the determination of mobile station position, with the returned information useful in directing the dispatch of emergency services aid.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the method and apparatus of the present invention may be acquired by reference to the following Detailed Description when taken in conjunction with the accompanying Drawings wherein:

FIGURE 1 is a block diagram of a cellular telephone network in accordance with the present invention which supports responding to requests regarding mobile station position;

FIGURE 2 is a block diagram of a base station system like that used in the cellular telephone network of FIGURE 1;

FIGURE 3 is a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 1 in a first scenario for providing position information on a target mobile station;

FIGURE 4 is a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 1 in a second scenario for providing position information on a target mobile station;

FIGURE 5 is a block diagram of a telephone network in accordance with the present invention which supports responding to requests regarding mobile station position;

FIGURE 6 is a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 5 for providing position information on a target mobile station;

FIGURE 7 is a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 5 in delivering mobile station position information to a data terminal;

FIGURE 8 is a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 5 in delivering mobile station position information to a telephone;

FIGURE 9 is a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 5 in delivering mobile station position information to a facsimile machine;

FIGURE 10 is a block diagram of a cellular telephone network in accordance with the present invention which supports delivery of mobile station position information to public service entities;

FIGURE 11 is a signal flow and nodal operation diagram illustrating the operation of the cellular telephone network of FIGURE 10 in providing position information on a mobile station during an ongoing cellular voice/data communication;

FIGURE 12 is a signal flow and nodal operation diagram illustrating the operation of the cellular telephone network of FIGURE 10 in providing information on a mobile station while in an idle operating mode;

FIGURE 13 is a block diagram of a cellular telephone network in accordance with the present invention equipped to provide emergency situation caller assistance; and

FIGURE 14 is a signal flow and nodal operation diagram illustrating the operation of the cellular telephone network of FIGURE 13 in providing location information on a mobile station for purposes of properly routing an emergency cellular call.

DETAILED DESCRIPTION OF THE DRAWINGS

Reference is now made to FIGURE 1 wherein there is shown a block diagram of a cellular telephone network including a plurality of individual Public Land Mobile Networks (PLMNs) 20 and 30. The first Public Land Mobile Network 20 includes a mobile switching center 26 connected to a plurality of base station systems (BSSs) 23, 24 and 25. It will, of course, be understood that the Network 20 likely includes a plurality of mobile switching centers 26. The mobile switching center 26 is further connected to a home location register 22. The second Public Land Mobile Network 30 is similarly configured having a mobile switching center 35 connected to a plurality of base station systems 31, 32 and 33. Again, it is likely that the Network 30 includes a plurality of mobile switching centers 35. The mobile switching center 35 is further connected to a home location register 34. At least one mobile switching center 26 of the first Public Land Mobile Network 20 and at least one mobile switching center 35 of second Public Land Mobile Network 30 are interconnected for both voice/data communications and signaling transmissions in a manner well known to those skilled in the art.

Reference is now additionally made to FIGURE 2 wherein there is shown a block diagram of the base station systems 23, 24, 25, 31, 32 or 33. Each base station system comprises a base station controller (BSC) 108 connected to a plurality of base stations (BS) 102, 104 and 106. At least one base station is provided for each cell in the network. It is through the base stations 102, 104 and 106 that radio frequency communications with proximately located mobile stations (MS) are effectuated. The base station controller 108 is connected to the mobile switching center 26 or 35 shown in FIGURE 1. Operation of a Public Land Mobile Network 20 or 30 in providing cellular communications services to mobile stations through the base station controller 108 and base stations 102, 104 and 106 is well known to those skilled in the art.

Referring now again to FIGURE 1, instances often arise wherein a subscriber (not shown) having a mobile station 10 or 40 desires to know the geographic position/location of another (target) subscriber mobile station 50. The cellular telephone network of FIGURE 1 supports responding to mobile station 10 and 40 position requests by determining the position of the target mobile station 50 and responding to the requesting mobile station in an appropriate manner.

Take first the scenario where the requesting mobile station 10 is located in a different Public Land Mobile Network 20 than the target mobile station 50. Additional reference is now made to FIGURE 3 wherein there is shown a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 1 in a first scenario for providing position information on the target mobile station 50. Requesting mobile station 10 first (action 200) enters a service feature code, identifying a mobile station position request, along with the mobile station integrated service directory number (MSISDN) of the target mobile station 50. A signal 202 is then sent over a control channel by the requesting mobile station 10 to its serving base station system 24 using an Unstructured Supplementary Service Data (USSD) or Direct Transfer Access Point (DTAP) message. Responsive thereto, the base station system 24 routes (signal 204) the request to the mobile switching center 26. The mobile switching center 26 analyzes the directory number of the requesting mobile station 10 to determine its home location register 22. A query (signal 206) is then sent to the home location register 22 requesting confirmation that the requesting mobile station 10 is subscripted to the requested mobile station position service feature. A response (signal 208) is sent back to the mobile switching center 26. Alternatively, the requesting mobile station 10 subscription may be checked by the mobile switching center 26 itself (through its visitor location register), thus obviating the need for signals 206 and 208. If the response is affirmative, the mobile switching center 26 analyzes the directory number of the target mobile station 50, and sends a modified Mobile Application Part (MAP) message, referred to as a provide location information (PLI) request signal 210, to the home location register 34 for the target mobile station 50. The home location register 34 determines that mobile switching center 35 is currently serving the target mobile station 50. The provide location information request is then routed (signal 212) to mobile switching center 35. A location determination (action 214) with respect to the target mobile station 50 is then made in accordance with one of a number of known procedures. These procedures are briefly described later. The determined target mobile station 50 location information is then sent by the serving mobile switching center 35 to the home location register 34 again using a modified Mobile Application Part message signal 216. The information is then forwarded by signals 218, 220 and 222 through the mobile switching center 26 and base station system 24 to the requesting mobile station 10. The information is then processed (action 224) by the mobile station 10 and displayed (action 226) for subscriber review.

In a second scenario, the requesting mobile station 40 is located in the same Public Land Mobile Network 30 as the target mobile station 50. Additional reference is now made to FIGURE 4 wherein there is shown a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 1 in a second scenario for providing position information on a target mobile station 50. Requesting mobile station 40 first (action 200) enters a service feature code, identifying a mobile station position request, along with the mobile station integrated service directory number (MSISDN) of the target mobile station 50. A signal 202 is then sent over a control channel by the requesting mobile station 40 to its serving base station system 31 using an Unstructured Supplementary Service Data (USSD) or Direct Transfer Access Point (DTAP) signal. Responsive thereto, the base station system 31 routes (signal 204) the request to the mobile switching center 35. The mobile switching center 35 analyzes the directory number of the requesting mobile station 40 to determine its home location register 34. A query (signal 206) is then sent to the home location register 34 requesting confirmation that the requesting mobile station 40 is subscripted to the requested mobile station position service feature. A response (signal 208) is sent back to the mobile switching center 35. Again, subscription verification may be performed directly by the mobile switching center 35 obviating the need for signals 206 and 208. If the response is affirmative, the mobile switching center 35 analyzes the directory number of the target mobile station 50, and sends a modified Mobile Application Part (MAP) message, referred to as a provide location information (PLI) request signal 210, to the home location register 34 for the target mobile station 50. The home location register 34 determines that mobile switching center 35 is currently serving the target mobile station 50. The provide location information request is then routed (signal 212) back to mobile switching center 35. A location determination (action 214) with respect to the target mobile station 50 is then made in accordance with one of a number of known procedures. These procedures are briefly described herein. The determined target mobile station 50 location information is then sent by the serving mobile switching center 35 to the home location register 34 using a modified Mobile Application Part message signal 216. The information is then forwarded by signals 218, 220 and 222 back through the mobile switching center 35 and base station system 31 to the requesting mobile station 40. The information is then processed (action 224) by the mobile station 40 and displayed (action 226) for subscriber review.

Although mobile stations 40 and 50 are illustrated in FIGURE 1 as being served by the same mobile switching center 35 of the second Public Land Mobile Network 30, it will be understood that this need not necessarily be so. When different mobile switching centers 35 are involved, the signals 212 and 220 are routed to the correct one of the mobile switching centers in a manner well known in the art (and similarly to that illustrated in FIGURE 3).

Reference is now made to FIGURE 5 wherein there is shown a block diagram of a telephone network including a Public Switched Telephone Network 90 and a Public Land Mobile Network 30. The Public Land Mobile Network 30 is similar to that shown in FIGURES 1 and 2 to include a mobile switching center 35 connected to a plurality of base station systems 31, 32 and 33. The mobile switching center 35 is further connected to a home location register 34. The Public Switched Telephone Network 90 is not illustrated in detail, but does include, for purposes of the present invention, an end office exchange (EO) 82. Connected to the end office 82 are a telephone unit (TU) 70, data terminal equipment (DTE) 72 (comprising, perhaps, a personal computer), and a facsimile machine (FAX) 74. The mobile switching center 35 of the Public Land Mobile Network 30 and the end office 82 of the Public Switched Telephone Network 90 are interconnected for both voice/data communications and signaling transmissions in a manner well known to those skilled in the art.

Instances often arise wherein a person (not shown) having a telephone unit 70 desires to know the geographic position/location of a subscriber mobile station 50. The telephone network of FIGURE 5 supports responding to telephone unit 70 position requests by determining the position of the target mobile station 50 and responding to the requesting person in an appropriate manner.

Reference is now additionally made to FIGURE 6 wherein there is shown a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 5 for determining the position of a target mobile station 50. Requesting telephone unit 70 first (action 201) enters a service feature code, identifying a mobile station position request, along with the mobile station integrated service directory number (MSISDN) of the target mobile station 50. The manner of position information delivery (i.e., voice back to the telephone unit, or data to either the data terminal equipment 72 or facsimile machine 74) is also specified. A signal 203 is accordingly sent from the requesting telephone unit 70 to its serving end office 82. Responsive thereto, the Public Switched Telephone Network 90 then confirms (action 205) that the requesting telephone unit 70 is subscripted to the requested mobile station position service feature. If this is confirmed, the end office 82 analyzes the directory number of the target mobile station 50, and sends a modified Mobile Application Part (MAP) message or perhaps a Transaction Control Application Part (TCAP) message, referred to as a provide location information (PLI) request signal 207, to the home location register 34 for the target mobile station 50. The home location register 34 determines that mobile switching center 35 is currently serving the target mobile station 50. The provide location information request is then routed (signal 209) to mobile switching center 35. A location determination (action 211) with respect to the target mobile station 50 is then made in accordance with one of a number of known procedures. These procedures are briefly described later. The determined target mobile station 50 location information is then sent by the serving mobile switching center 35 to the home location register 34 using a modified Mobile Application Part message signal 213. The information is then forwarded by signals 215 and 217 through the end office 82 of the Public Switched Telephone Network 90 to an adjunct processing node (APN) 76. It will, of course, be understood that the adjunct processing node 76 functionality may be provided within the end office 82 itself. The manner of position information delivery input by the person at the telephone unit 70 is then processed (action 219) to determine whether the position information should be delivered to the telephone unit, data terminal equipment 72 or the facsimile machine 74.

Reference is now made to FIGURE 7 wherein there is shown a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 5 in delivering mobile station position information to the data terminal equipment 72. Following processing in action 219 to identify the data terminal equipment 72 as the delivery destination for the position information, the adjunct processing node 76 properly formats (action 221) the position information for data delivery, initiates a call (action 223) through the end office 82 to the data terminal equipment 72, and transmits the formatted position information over call connection 225.

Reference is now made to FIGURE 8 wherein there is shown a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 5 in delivering mobile station position information to the telephone unit 70. Following processing in action 219 to identify the telephone unit 70 as the delivery destination for the position information, the adjunct processing node

76 initiates a call (action 229) through the end office 82 to the telephone unit 70. Once a call connection 231 is established between the adjunct processing node 76 and telephone unit 70, the adjunct processing node synthesizes (action 233) a voice message relating the determined position information to the requesting person.

Reference is now made to FIGURE 9 wherein there is shown a signal flow and nodal operation diagram illustrating operation of the network of FIGURE 5 in delivering mobile station position information to a facsimile machine 74. Following processing in action 219 to identify the facsimile machine 74 as the delivery destination for the position information, the adjunct processing node 76 properly formats (action 221) the position information for facsimile delivery, initiates a call (action 235) through the end office 82 to the facsimile machine 74, and transmits the formatted position information over the established call connection 237.

With reference now again to FIGURES 1 and 5, a plurality of different mechanisms exist for determining the position of the mobile station 50 operating within the cellular telephone network. Although several location determination techniques are discussed below, it will be recognized that any suitable position determination mechanism may be used.

One way to determine position is to rely on information supplied from a Global Positioning System (GPS) transceiver 52 connected to the target mobile station 50. Responsive, perhaps, to requests from a base station system, or on a periodic basis, geo-coordinates are extracted by the target mobile station 50 and transmitted over a control channel of the air interface to the base station system. This information is then relayed to the serving mobile switching center, processed by an adjunct processing node (APN) 36 in the manner described above in connection with the location determination actions 211 and 214, and transmitted back through the network for presentation to the requesting entity.

A second way to determine position is to use the cell area where the target mobile station 50 is currently located. Identification information for the currently serving base station and cell is available to the network and in particular to the base station system. This information is relayed to the serving mobile switching center, processed by the adjunct processing node 36 in the manner described above in connection with the location determination actions 211 and 214, and transmitted back through the network for presentation to the requesting entity.

A third way to determine position is to use measurements (signal strength or timing advance) made by the base stations in the vicinity of the target mobile station 50. Responsive, perhaps, to requests from a base station system, or on a periodic basis, measurement information is acquired by the base station system serving the target mobile station 50 and relayed to the mobile switching center. This information is then processed by the adjunct processing node 36 in the manner described above in connection with the location determination actions 211 and 214, and transmitted back through the network for presentation to the requesting entity. In particular, the adjunct processing node 36 utilizes well known triangulation and arcuation processes to identify a position from the received measurement information.

A fourth way to determine position is to use measurements (signal strength or timing advance) made by the target mobile station 50 itself. Responsive, perhaps, to requests from a base station system, or on a periodic basis, measurement information is acquired by the target mobile station 50 and relayed to the mobile switching center through the serving base station system. This information is then processed by the adjunct processing node 36 in the manner described above in connection with the location determination actions 211 and 214, and transmitted back through the network for presentation to the requesting entity. In particular, the adjunct processing node 36 utilizes well known triangulation and arcuation processes to identify a position from the received measurement information.

A fifth way to determine position is to rely on a determination made by a separate location system (SLS) 60. The separate location system 60 utilizes a known location determination system, such as GPS, satellite Doppler, LORAN-C, direction finding, time or arrival triangulation (arcuation), or signal strength triangulation (arcuation). Responsive to a request, or perhaps on a periodic basis, the separate location system 60 sends position information to the mobile switching center. This information is then processed in the manner described above in connection with the location determination actions 211 and 214, and transmitted back through the network for presentation to the requesting entity.

Reference is now made to FIGURE 10 wherein there is shown a block diagram of a cellular telephone network 300 comprising a mobile switching center (MSC) 302, a base station controller (BSC) 304, and a plurality of base stations (BS) 306. The base station controller 304 and associated base stations 306 form a base station system (BSS) 308. Each base station 306 is configured to engage in radio frequency communications over an air interface 310 with proximately located mobile stations (MS) 312. The air interface 310 supports the transmission of both voice/data communications as well as signaling communications. In general, communications are effectuated with those mobile stations 312 located near or within the confines of a cell 314 associated with each base station 306. The mobile switching center 302 and base station controller 304 are connected via a communications link 316 which supports the transmission of both voice/data communications as well as signaling communications. The base station controller 304 and associated base stations 306 are connected via communications links 318 which, like the links 316, support the transmission of both voice/data communications as well as signaling communications. Operation of the cellular telephone network 300 in providing conventional cellular voice/data calling services to mobile station subscribers is well known to those skilled in the art, and accordingly will not be discussed herein.

A law enforcement agency is often authorized to monitor cellular telephone calls to obtain evidence for use in criminal investigations. To accomplish this goal, a monitoring center (MC) 320 is established which may include a tape recorder 322 for recording the voice conversation that is being monitored. The physical connection with the voice/data communications portion of the cellular telephone network 300 is made through a tap (generally shown at 324). The tap 324 may be made at any location within the cellular telephone network 300 in a manner well known to those skilled in the art, but is typically made at a selected one of the mobile switching centers 302 associated with the base station 306 and cell 314 where the mobile station 312 is currently located (roaming).

A number of instances may arise where the location of a mobile station 312 (or its possessing cellular subscriber) needs to be known by the law enforcement agency. One instance occurs in connection with the monitoring of an ongoing cellular telephone call. Another instance occurs when the mobile station 312 is idle, but the law enforcement agency desires to track its location.

Reference is now additionally made to FIGURE 11 wherein there is shown a signal flow and nodal operation diagram illustrating the operation of the cellular telephone network 300 of FIGURE 10 in providing position on a mobile station 312 during an ongoing cellular voice/data communication 330. It is assumed that all of the conventional, well known, cellular network operations preceding the establishment of the actual communication 330 (for example, authentication, ciphering, call set-up) have already occurred. The portion of the voice/data communication 330 carried over the air interface 310 utilizes a traffic channel (TCH). A control channel (CCH) is also provided over the air interface 310 for parallel mobile station 312 use during the ongoing call.

Suppose now that the law enforcement agency desires to know the location of the mobile station 312 which is engaging in the communication 330. From either its monitoring center 320 (as shown) or another selected location, the law enforcement agency signals 332 the network 300, and in particular the serving mobile switching center 302, to request location information. This request signal 332 includes not only the identification number (MIN, IMSI, IMEI, MSISDN, and/or MSID) of the mobile station 312 to be located, but also the degree of accuracy to be provided with the location determination. This degree of accuracy parameter specifies the precision with which the location determination is expected to be made (for example, actual location within one-hundred fifty meters radius of determined location).

Once the request signal 332 is received by the serving mobile switching center 302, the identification number of the mobile station 312 to be located is processed (action 334), and it is determined that the mobile station at issue is engaged in the communication 330. Thus, the network does not have to search (for example, page) for the mobile station 312 before making the location determination. A position request signal 336 is then sent by the mobile switching center 302 to the base station system 308 serving the mobile station 312 over the communications link 316 as a connection oriented signaling connection control part (SCCP) session. The position request signal 336 includes a plurality of parameters in addition to the parameters specified in the location request signal 332, including: the confidence factor with which the location position is to be reported; the expected method of reporting the location position; the periodicity with which reports are to be made; and, the kind of location determination that is to be made. The confidence factor parameter specifies the degree of confidence with which mobile station 312 location must be determined (for example, seventy percent in view of the specified accuracy parameter). The method of reporting parameter specifies that either: spontaneous position information is expected; single position information is expected; periodic position information is expected; or, no position information is expected. The periodicity parameter specifies how often (for example, every three minutes) mobile station 312 position is to be determined and reported to the requesting entity. The kind of location determination parameter specifies which one of a plural number of available determination methods (for example, signal strength analysis, timing advance analysis, or global positioning system determination) is to be used in determining mobile station 312 position.

Responsive to the position request signal 336, the base station system 308 serving the mobile station 312 makes the requested position request determination (action 338). The making of the position request determination in action 338 can take on one of several options. First, for example, if the mobile station 312 is equipped with a global positioning system (GPS) receiver 340, and if the mobile station has transmitted its geo-coordinates to the base station system 308 over the control channel (CCH) of the air interface 310, and further if the kind of location determination parameter specifies GPS, the action 338 merely comprises the capturing of the transmitted information, and the formatting of the position information for transmission back to the mobile switching center 302. Second, on the other hand, if the kind of location determination parameter specifies one of the measurement location methods (like, signal strength analysis or timing advance analysis) the action 338 primarily involves the capturing of the requisite measurement information. Then, if the base station system 308 is connected to a location processing device (LPD) 340, the action 338 further includes the processing of the measurement information to determine mobile station 312 position, and the formatting of the position information for transmission back to the mobile switching center 302. If no location processing device (LPD) 340 is immediately available to the base station system 308, the action 338 includes the collection of the measurement data, and the formatting of the position information for transmission back to the mobile switching center 302. In connection with the measurement location methods, if the measurement data is collected by the mobile station 312 itself (for example, during mobile assisted hand-off measurement), the data is transmitted to the base station system 308 over the control channel (CCH) of the air interface 310. Alternatively, the measurement data is collected by the base station 306 portion of the base station system 308 (for example, during hand-off determination or timing advance analysis).

Once the position request determination in action 338 is completed, a responsive position indication signal 342 is then sent by the base station system 308 serving the mobile station 312 to the mobile switching center 302 over the communications link 316 as a connection oriented signaling connection control part (SCCP) session. The method of reporting parameter within the position request signal 336 specifies the expected nature with which the position indication signal 342 is to be sent by the base station system 308. If the parameter specifies that spontaneous position information is expected, each time the position of the mobile station 312 is determined in action 338 with a confidence factor equal or superior to the factor specified in the confidence factor parameter of the position request signal 336, the position indication signal 342 is spontaneously sent. If the parameter specifies that single position information is expected, the action 338 implemented by the base station system 308 tries to achieve the position of the mobile station 312 within the preset confidence factor and respond with the position indication signal 342 within a preset time period. If the time period expires before the confidence factor is met, the base station system 308 then responds with the position indication signal 342 which includes an estimated confidence factor for the determined position. If the parameter specifies that periodic position information is expected, the action 338 implemented by the base station system 308 responds with the position indication signal 342 with or without meeting the preset confidence factor, and thereafter responds according to the periodicity specified by the periodicity parameter. If the parameter specifies that no position information is expected, the action 338 implemented by the base station system 308 responds with the position indication signal 342 which does not include any position information and stops any position information process related to that particular mobile station.

The location processing device 340 need not be directly connected to the base station system 308. Instead, or additionally, the device 340' may be directly connected to the mobile switching center 302. In such a case where the position determination is not made in association with the base station system 308 (i.e., the action 338 involves the collection of and the formatting of the measurement data), the measurement data is transmitted to the mobile switching center 302 in the position indication signal 342 and the requested position request determination (action 338') is thereafter made by the location processing device 340'.

Following receipt of each position indication signal 342 by the mobile switching center 302, the position information is processed and/or formatted (action 344), if necessary, and a request location information response signal 346 is transmitted from the mobile switching center to the monitoring center 320 (as shown) of the requesting law enforcement agency. It will, of course, be understood that the requesting entity need not necessarily be restricted to a law enforcement agency as shown. In fact, the position information provided by the network 300 is equally important to other public service agencies such as the fire department and emergency services department (ambulance and rescue squads). Furthermore, the position information is also valuable in fleet/delivery vehicle environments to track the locations of vehicles and personnel. As yet another alternative, the mobile station 312 itself may comprise the requesting entity.

Reference is now made to FIGURE 12 wherein there is shown a signal flow and nodal operation diagram illustrating the operation of the cellular telephone network 300 of FIGURE 10 in providing position information on a mobile station 312 while in an idle operating mode. Unlike the operation described in connection with FIGURE 11, when the request signal 332 is received, the serving mobile switching center 302 may not know where the mobile station 312 with the specified identification number operating in idle mode is located. Thus, the network 300 must search (for example, page) for the mobile station 312. Instead of sending the position request signal 336, the mobile switching center 302 sends a position/tracking request signal 350 to perhaps plural ones of the base station systems 308 (only one shown) over the communications link 316 as a connection-less signaling connection control part (SCCP) session. The position/tracking request signal 350 is sent to plural base station systems 308, rather than a single base station system as with the position request signal 336, in those instances where the location within the network 300 of the idle mobile station 312 is not known. This position/tracking request signal 350 includes the same parameters as the previously described position request signal 336 including Mobile Station Identification (MIN, IMSI, IMEI, MSISDN, and/or MSID).

Responsive to the position/tracking request signal 350, the base station system 308 builds a tracking group (action 352), analogous to a paging group, and broadcasts a tracking request signal 354, analogous to a paging request signal, through each of its associated base stations 308 (not shown), in an attempt to reach the idle mobile station 312. The tracking request signal 354 is transmitted by the base stations 306 using a common control channel (CCCH) over the air interface 310. If the idle mobile station 312 receives the tracking request signal 354, it transmits a channel request signal 356 to the base station system 308 using a dedicated control channel (DCCH) of the air interface 310. The base station system 308 responds with the assignment of a channel (signal 358), and the mobile station 312 replies by sending a tracking response signal 360, which is analogous to a paging response. This tracking response signal 360 may additionally include geo-coordinate and/or measurement information relating to mobile station 312 position determination.

The base station system 308 then forwards the tracking response signal 360 to the mobile switching center 302 over the communications link 316 as the responsive position indication signal 342, again analogous to the paging response, using a connection oriented signaling connection control part (SCCP) session. If the base station system 308 is connected to the location processing device (LPD) 340, the position request determination (action 338) is performed, and any received measurement information is processed to determine mobile station 312 position. The determined position information is then transmitted to the mobile switching center 302 using the responsive position indication signal 342. If no location processing device 340 is immediately available to the base station system 308, or if global positioning system geo-coordinates were received, the action 338 includes the collection and formatting of the measurement data (or geo-coordinates), and the responsive position indication signal 342 carries the formatted information to the mobile switching center 302. In a manner similar to that illustrated in FIGURE 11, the responsive position indication signal 342 is sent in accordance with the method of reporting parameter contained within the position/tracking request signal 350. Following receipt of the forwarded tracking response signal 360 in the form of the responsive position indication signal 342, the mobile switching center 302 sends a confirmation signal 362 to the base station system 308.

The network 300 then proceeds to authenticate (action 364) the mobile station 312 in a manner well known to those skilled in the art. If the authentication is successful, the mobile switching center 302 is then authorized (action 366) to report position information to the monitoring center 320 (as shown) of the requesting law enforcement agency using the request location information response signal 346. If position information was received in (or obtained from) the forwarded tracking response signal 360, this information is then reported following authorization to the requesting entity in accordance with the method of reporting parameter contained within the position/tracking request signal 350. If no position information was yet received, or if additional information is expected, completion of the authentication process 364 authorizes subsequent base station system 308 transmission of the responsive position indication signal 342 in accordance with the method of reporting parameter contained within the position/tracking request signal 350.

Again, the location processing device 340 need not be directly connected to the base station system 308. Instead, or additionally, the device 340' may be directly connected to the mobile switching center 302. In such a case where the position determination is not made in association with the base station system 308 (i.e., the action 338 involves the collection of the and formatting of the measurement data), the measurement data is transmitted to the mobile switching center 302 in the position indication signal 342 and the requested position request determination (action 338') is thereafter made by the location processing device 340'.

Reference is now made to FIGURE 13 wherein there is shown a block diagram of a cellular telephone network 400 equipped to provide emergency situation caller assistance. The cellular telephone network 400 includes a plurality of mobile switching centers (MSC) 402. Associated with each mobile switching center 402 is a base station controller (BSC) 404 connected to a plurality of base stations (BS) 406. Each base station controller 404 and its associated base stations 406 form a base station system (BSS) 408. Each base station 406 is configured to engage in radio frequency communications over an air interface 410 with proximately located mobile stations (MS) 412. The air interface 410 supports the transmission of both voice/data communications as well as signaling communications. In general, communications are effectuated with those mobile stations 412 located near or within the confines of a cell 414 associated with each base station 406. The mobile switching center 402 and base station controller 404 are connected via a communications link 416 which supports the transmission of both voice/data communications as well as signaling communications. The base station controller 404 and associated base stations 406 are connected via communications links 418 which, like the links 416, support the transmission of both voice/data communications as well as signaling communications. The mobile switching centers 402 are interconnected by communications links 420 which, like the links 416 and 418, also support the transmission of both voice/data communications as well as signaling communications. Operation of the cellular telephone network 400 in providing conventional cellular voice/data calling services to mobile station subscribers is well known to those skilled in the art, and accordingly will not be discussed herein.

Connected to the cellular telephone network 400 via routers 423 are a plurality of public safety answering point (PSAP) systems 422. Each public safety answering point system 422 is utilized by emergency service providers (such as the police department, fire department, or rescue department) as a central point for the reception of emergency services telephone calls (e.g., dial 911 calls) and the dispatching of emergency services personnel within an associated emergency service area. Certain mobile switching centers 402 are assigned to a certain public safety answering point system 422. In fact, it is possible that one mobile switching center 402 may be serviced by more than one public safety answering point system 422.

It is important that any cellular emergency call initiated from a mobile station 412 be handled by the proper public safety answering point system 422. Generally, this means the public safety answering point system 422 controlling the dispatching of proximately located emergency services personnel. If a cellular emergency call is misrouted, the dispatching and/or arrival of emergency aid could be delayed. Under normal cellular telephone system operating conditions, this is not a concern as the cellular emergency call is handled by the mobile switching center 402 for the service area where the emergency call is originated (the serving MSC) and routed through router 423 to the public safety answering point system 422 connected thereto. For those situations where a service area and its mobile switching center 402 are associated with plural public safety answering point systems 422, routing is made to the public safety answering point system 422 assigned to the cell 414 currently serving the mobile station 412. When the mobile subscriber is on-call, roaming and switches serving mobile switching centers 402, however, a communications link is maintained through the mobile switching center 402(1) for the service area where the first call was originated (the anchor MSC). Any cellular emergency call thereafter initiated (by placing the original call on hold) is then incorrectly, and perhaps undesirably, routed through the anchor mobile switching center 402(1) to its assigned (connected) public safety answering point system 422 via router 423 instead of to the public safety answering point system 422 for the serving mobile switching center 402(2).

Reference is now additionally made to FIGURE 14 wherein there is shown a signal flow and nodal operation diagram illustrating the operation of the cellular telephone network 400 of FIGURE 13 in providing location information on a mobile station 412 for purposes of routing an emergency cellular call to the proper public safety answering point system 422. In conjunction with anchor mobile switching center 402(1) receipt of a cellular emergency call 424 originated by a roaming mobile station 412 while maintaining an original call 425 (on hold), an identification is also provided of the cell 414 associated with base station 406 serving the mobile station. The data base 426(1) connected to the anchor mobile switching center 402(1) does not include translation information correlating the identified cell 414 with the routing identification number for its associated public safety answering point system 422. This is because this information is instead stored in the data base 426(2) connected to the serving mobile switching center 402(2). Thus, the anchor mobile switching center

402(1) does not possess sufficient information to properly route the call.

Recognizing then the situation of a roaming mobile station 412 making a cellular emergency call 424 with a prior call 425 on hold, the anchor mobile switching center 402(1) sends a position request with location number requested signal 428 to the serving mobile switching center 402(1) over the communications link 420 as a Mobile Application Part (MAP) message. This position request signal 428 optionally includes an identification of the cell 414 where the mobile station 412 is located, and a location type parameter which requests the return of a routing identification number for that cell. Responsive to receipt of the location number request signal 428, the serving mobile switching center 402(2) processes (action 430) the identified cell in its data base 426(2) which includes translation information correlating the identified cell 414 with the routing identification number for its associated public safety answering point system 422. The retrieved routing identification number is then included in a response signal 432 transmitted from the serving mobile switching center 402(2) to the anchor mobile switching center 402(1) over the communications link 420. Using the retrieved routing identification number, the anchor mobile switching center 402(1) forwards (action 434) the cellular emergency call 424 to the public safety answering point system 422 assigned to the cell 414 currently serving the mobile station 412.

Instances may arise where position information regarding the roaming, cellular emergency calling mobile station 412 is also needed to handle the call. One option is for the transmitted signal 428 to be treated by the network 400 as a position request signal 332 (see, FIGURE 11) as well. Responsive thereto, and via the maintained connection through the anchor mobile switching center 402(1), the serving mobile switching center 402(2) not only retrieves the routing identification number for the proper public safety answering point system 422 for delivery to the anchor mobile switching center, but also initiates the position determination procedure illustrated in FIGURE 11. Following receipt of each position indication signal 342 by the anchor mobile switching center 402(1), the position information is processed and/or formatted (action 344), if necessary, and a request position information response signal 346 is transmitted from the mobile switching center to the proper public safety answering point system 422 via the anchor mobile switching center 402(1). Alternatively, in response to the forwarding (action 434) of the cellular emergency call 424, the public safety answering point system 422 transmits a position request signal 332 (see, FIGURE 11) towards the serving mobile switching center 402(2) via the anchor mobile switching center 402(1). Following receipt of each position indication signal 342 by the serving mobile switching center 402(2), the position information is processed and/or formatted (action 344), if necessary, and a request position information response signal 346 is transmitted to the public safety answering point system 422 via the anchor mobile switching center 402(1).

Although a preferred embodiment of the method and apparatus of the present invention has been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the embodiment disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention as set forth and defined by the following claims.

WHAT IS CLAIMED IS:

1. In a cellular telephone network including a first mobile switching center currently serving a target mobile station and a second mobile switching center currently serving a requesting mobile station, a method comprising the steps of:

routing a request for target mobile station position made by the requesting mobile station from the second mobile switching center to the first mobile switching center;

processing position indicative information to determine a position of the target mobile station; and

routing a response to the position request including target mobile station position from the first mobile switching center to the second mobile switching center.

2. The method as in claim 1 wherein the cellular telephone network includes a first public land mobile network having the first mobile switching center and a second public land mobile network having the second mobile switching center, and the steps of routing comprise the steps of routing the position request and response between the first and second public land mobile networks.

3. The method as in claim 2 wherein the first public land mobile network includes a home location register for the target mobile station, and the steps of routing further comprise the steps of routing the position request and response between the first and second mobile switching center through the home location register.

4. The method as in claim 1 wherein the cellular telephone network includes a public land mobile network having both the first and second mobile switching centers.

5. The method as in claim 1 further including the step of verifying requesting mobile station subscription

to a service feature supporting the request for target mobile station position.

6. The method as in claim 1 further including the steps of:

forwarding the response to the position request including target mobile station position from the second mobile switching center to the requesting mobile station;

processing of the included target mobile station position; and

displaying at the requesting mobile station of the target mobile station position.

7. In a telephone network including a public switched telephone network connected through an end office exchange to a requesting subscriber station and a cellular telephone network having a mobile switching center currently serving a target mobile station, a method comprising the steps of:

routing a request for target mobile station position made by the requesting subscriber station from the end office exchange to the mobile switching center;

processing position indicative information to determine a position of the target mobile station; and

routing a response to the position request including target mobile station position from the mobile switching center to the end office exchange.

8. The method as in claim 7 further including the step of verifying requesting subscriber station subscription to a service feature supporting the request for target mobile station position.

9. The method as in claim 7 further including the steps of:

placing a call through the end office exchange to the requesting subscriber station; and

delivering the target mobile station position to a requesting subscriber as a synthesized voice message.

10. The method as in claim 7 further including the steps of:

placing a call through the end office exchange to a facsimile machine associated with a requesting subscriber; and

delivering the target mobile station position to the requesting subscriber as a facsimile message.

11. The method as in claim 7 further including the steps of:

placing a call through the end office exchange to a data terminal associated with a requesting subscriber; and

delivering the target mobile station position to the requesting subscriber as a data message.

12. The method as in claim 7 wherein the mobile switching center is connected to a home location register of the target mobile station, and the steps of routing comprise the steps of routing the position request and response between the mobile switching center and end office exchange through the home location register.

13. In a cellular telephone network including mobile switching center connected to a base station system currently serving a target mobile station, a method comprising the steps of:

receiving at the mobile switching center a request from a requesting entity for target mobile station position;

routing the request for target mobile station position to the base station system currently serving the target mobile station;

collecting by the base station system of target mobile station position indicative information;

processing the position indicative information to determine a position of the target mobile station; and routing a response including the target mobile station position through the mobile switching center to the requesting entity.

14. The method as in claim 13 wherein the step of collecting comprises the step of obtaining position related measurement information collected by the target mobile station itself.

15. The method as in claim 14 wherein the position related measurement information comprises signal strength measurements.

16. The method as in claim 14 wherein the position related measurement information comprises timing advance measurements.

17. The method as in claim 13 wherein the step of collecting comprises the step of obtaining position related measurement information collected by the base station system itself.

18. The method as in claim 17 wherein the position related measurement information comprises signal strength measurements.

19. The method as in claim 17 wherein the position related measurement information comprises timing advance measurements.

20. The method as in claim 13 wherein the step of collecting comprises the step of obtaining geo-coordinate information collected by the target mobile station itself.

21. The method as in claim 13 wherein the position indicative information comprises position related measurement information, and the step of processing

comprises the step of arcuating the position related measurement information to determine the target mobile station position.

22. The method as in claim 13 wherein the position indicative information comprises position related measurement information, and the step of processing comprises the step of triangulating the position related measurement information to determine the target mobile station position.

23. The method as in claim 13 wherein the target mobile station is operating in an on-call mode, and wherein the step of routing comprises the step of routing the request to the base station system through which the target mobile station call is being handled.

24. The method as in claim 13 wherein the target mobile station is operating in an idle mode, and wherein the step of routing comprises the steps of:

paging for the target mobile station; and

routing the request to the base station system through which the target mobile station answers the page.

25. The method as in claim 13 further including the step of authenticating the target mobile station before allowing any target mobile station position response to be sent to the requesting entity.

26. A method, comprising the steps of:

responsive to mobile station hand-off during a first call from a first mobile switching center to a second mobile switching center, and further responsive to mobile station initiation of a second, emergency call while maintaining the first call, transmitting a request for mobile station location from the first mobile switching center to the second mobile switching center;

processing a current cell location for the mobile station to identify a public safety answering point serving the mobile station;

transmitting a response including the identified public safety answering point from the second mobile switching center to the first mobile switching center; and

routing the second, emergency call to the identified public safety answering point.

27. The method as in claim 26 further including the steps of:

collecting position indicative information for the mobile station;

processing the position indicative information to determine a position for the mobile station; and

routing the determined mobile station position to the identified public safety answering point.

28. The method as in claim 27 wherein the step of collecting comprises the step of obtaining position related measurement information collected by the target mobile station itself.

29. The method as in claim 28 wherein the position related measurement information comprises signal strength measurements.

30. The method as in claim 28 wherein the position related measurement information comprises timing advance measurements.

31. The method as in claim 27 wherein the step of collecting comprises the step of obtaining position related measurement information collected by the base station system itself.

32. The method as in claim 31 wherein the position related measurement information comprises signal strength measurements.

33. The method as in claim 31 wherein the position related measurement information comprises timing advance measurements.

34. The method as in claim 27 wherein the step of collecting comprises the step of obtaining geo-coordinate information collected by the target mobile station itself.

35. The method as in claim 27 wherein the position indicative information comprises position related measurement information, and the step of processing comprises the step of arcuating the position related measurement information to determine the target mobile station position.

36. The method as in claim 27 wherein the position indicative information comprises position related measurement information, and the step of processing comprises the step of triangulating the position related measurement information to determine the target mobile station position.

FIG.1

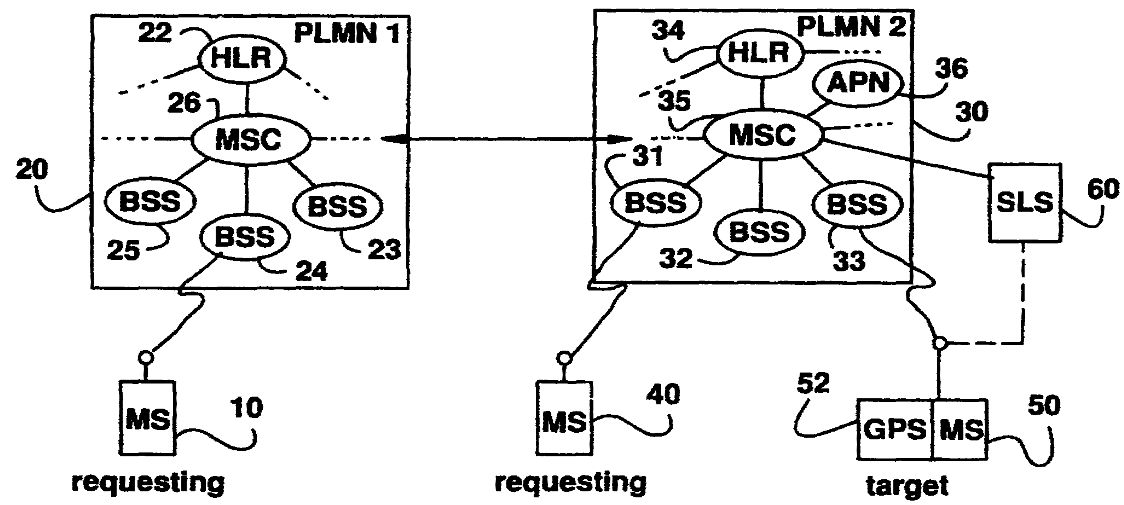



FIG.2

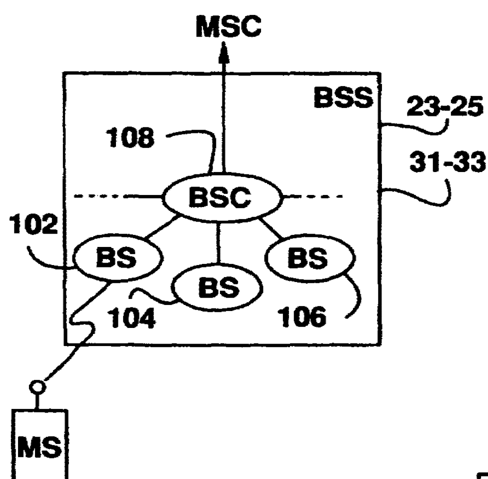



FIG.5

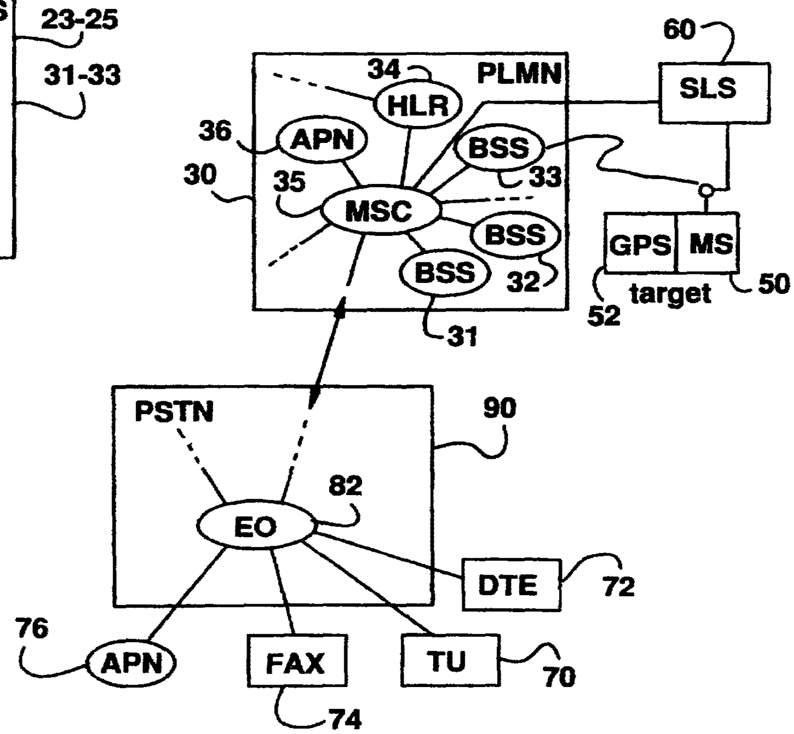


FIG.3

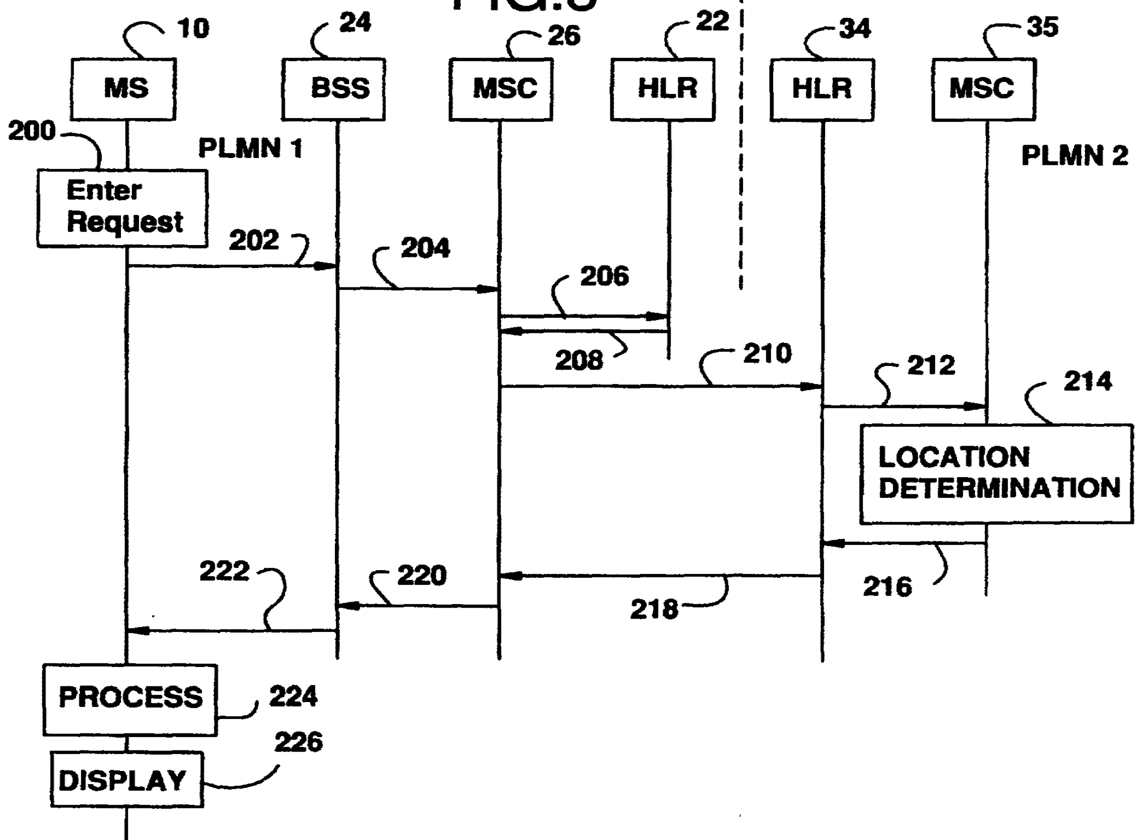
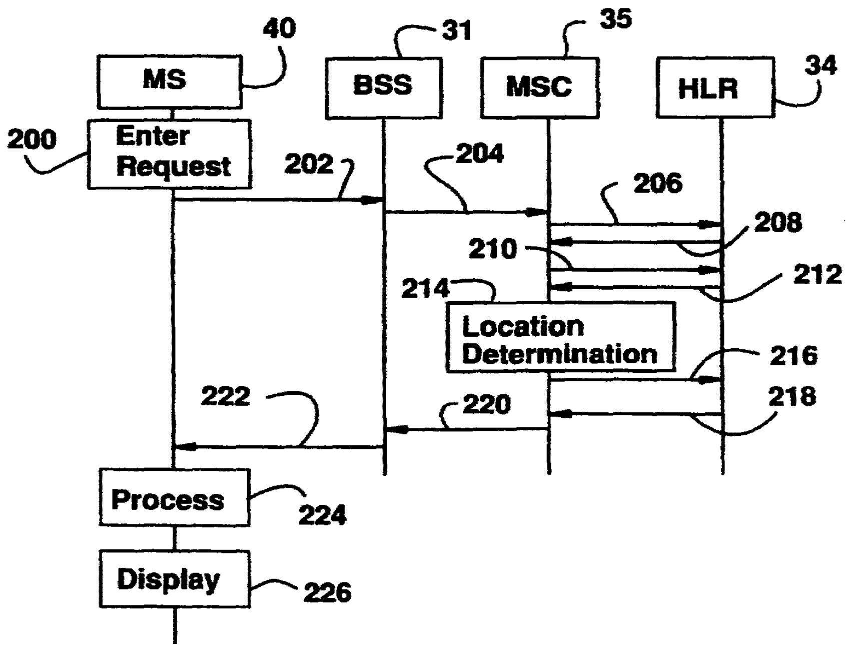

10
24
26
22
34
35
MS
BSS
MSC
HLR
HLR
MSC
200
PLMN 1
PLMN 2
Enter Request
202
204
206
208
210
212
214
LOCATION DETERMINATION
216
218
220
222
PROCESS
224
226
DISPLAY

FIG.4


40
31
35
34
MS
BSS
MSC
HLR
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Enter Request
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204
206
208
210
212
214
Location Determination
216
218
220
222
Process
224
Display
226

FIG.6

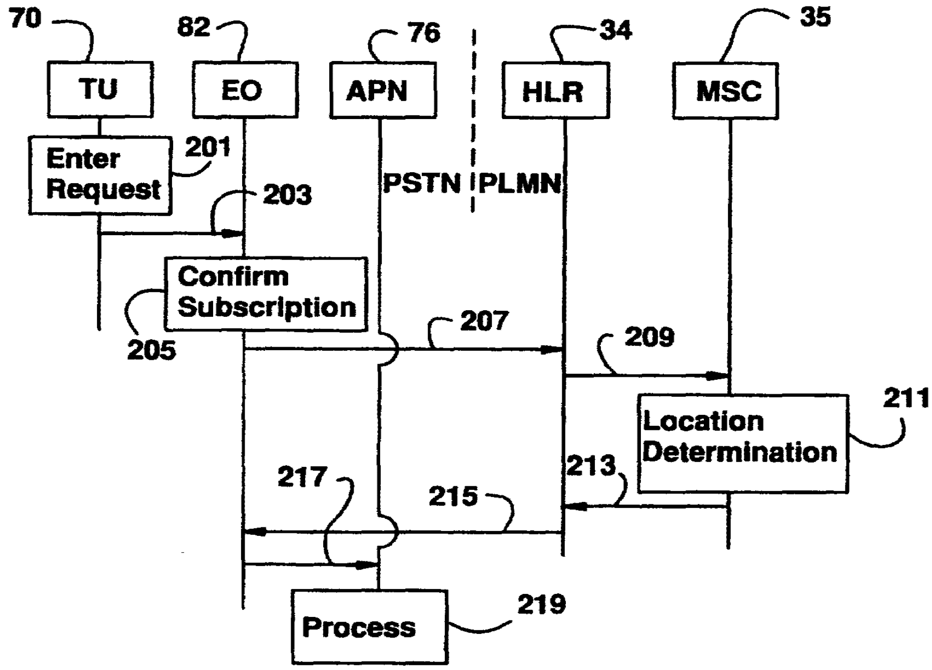



FIG.7

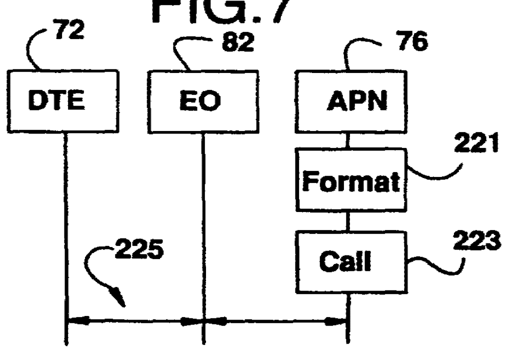



FIG.8

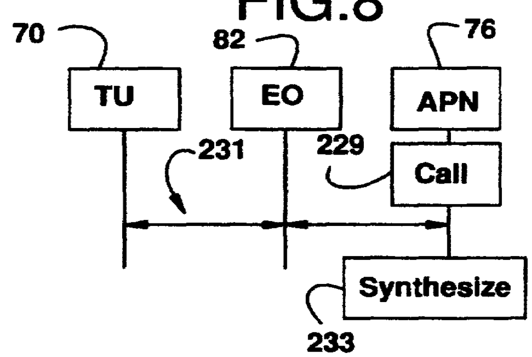



FIG.9

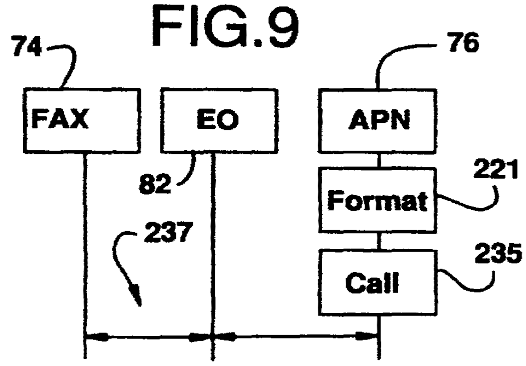
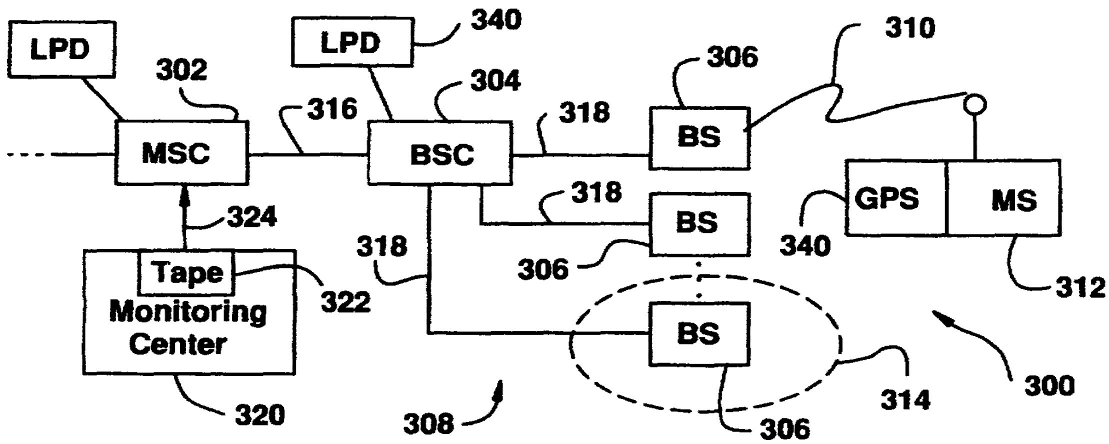


FIG.10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304
306
310
316
318
MSC
BSC
BS
318
GPS
MS
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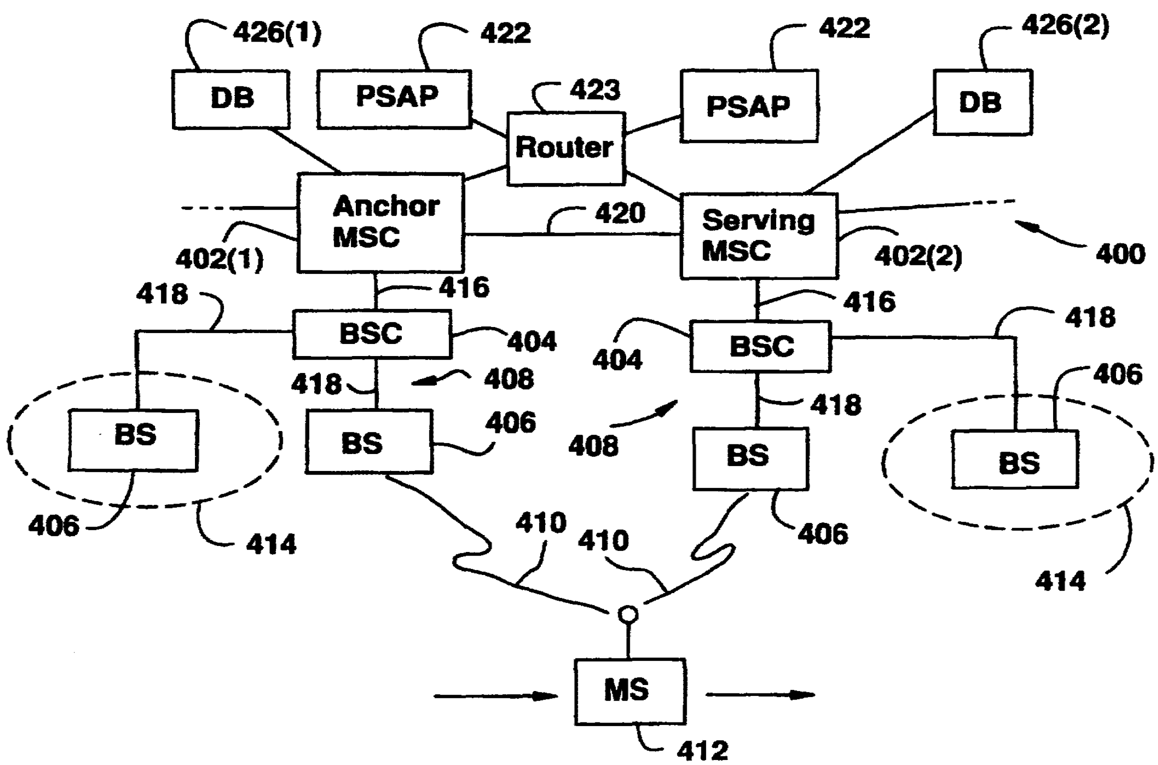
BS
340
318
Tape
Monitoring
Center
322
306
312
BS
314
300
320
308
306

FIG.13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422
422
426(2)
423
DB
PSAP
PSAP
DB
Router
Anchor
MSC
420
Serving
MSC
400
402(1)
402(2)
418
416
416
418
BSC
404
404
BSC
418
408
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BS
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408
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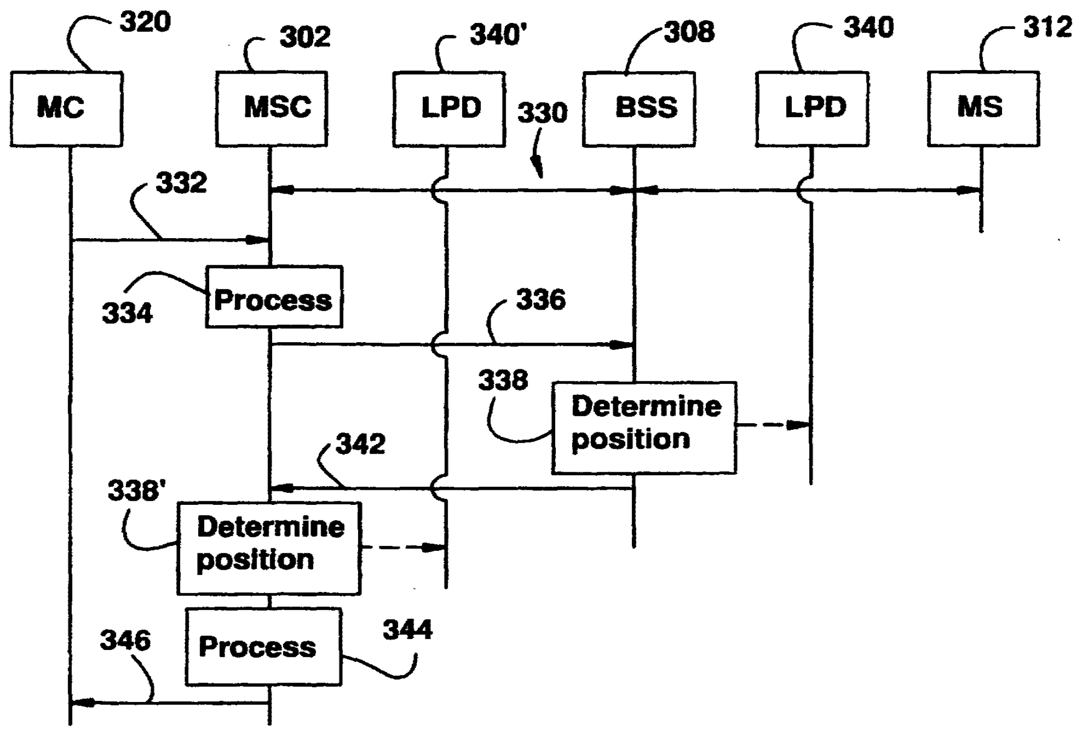
406
414
MS
412

FIG.11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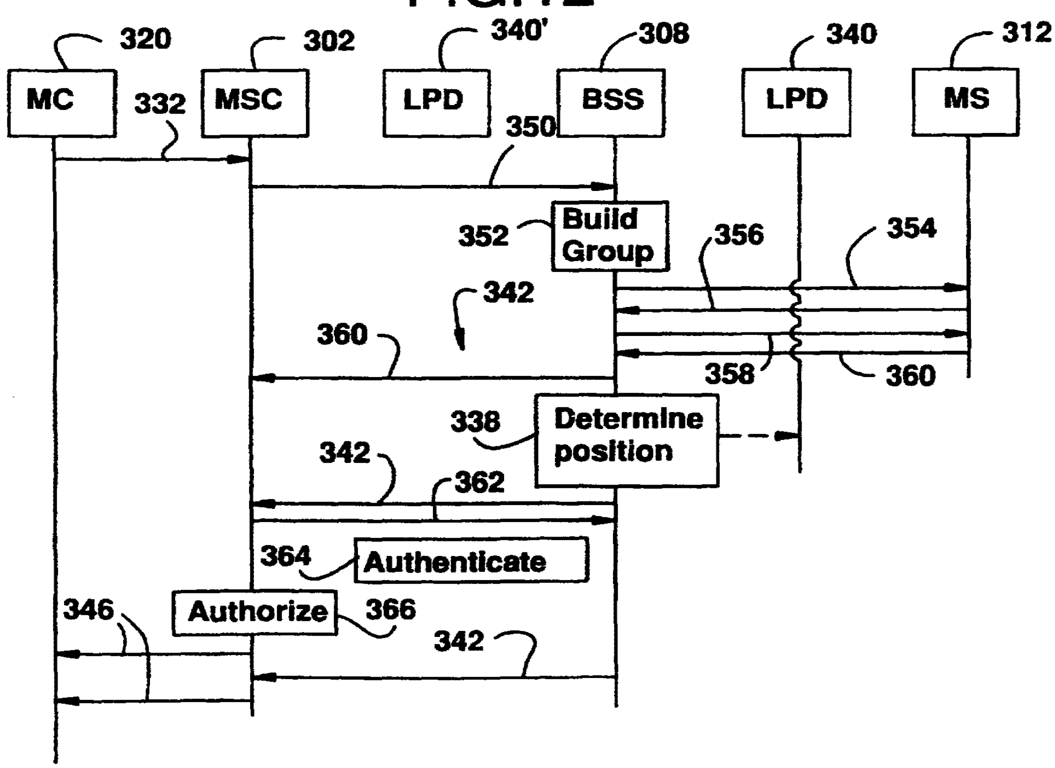
302
340'
308
340
312
MC
MSC
LPD
BSS
LPD
MS
330
332
Process
334
336
338
Determine position
342
338'
Determine position
346
Process
344

FIG.12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340'
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340
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MC
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MSC
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BSS
LPD
MS
350
352
Build Group
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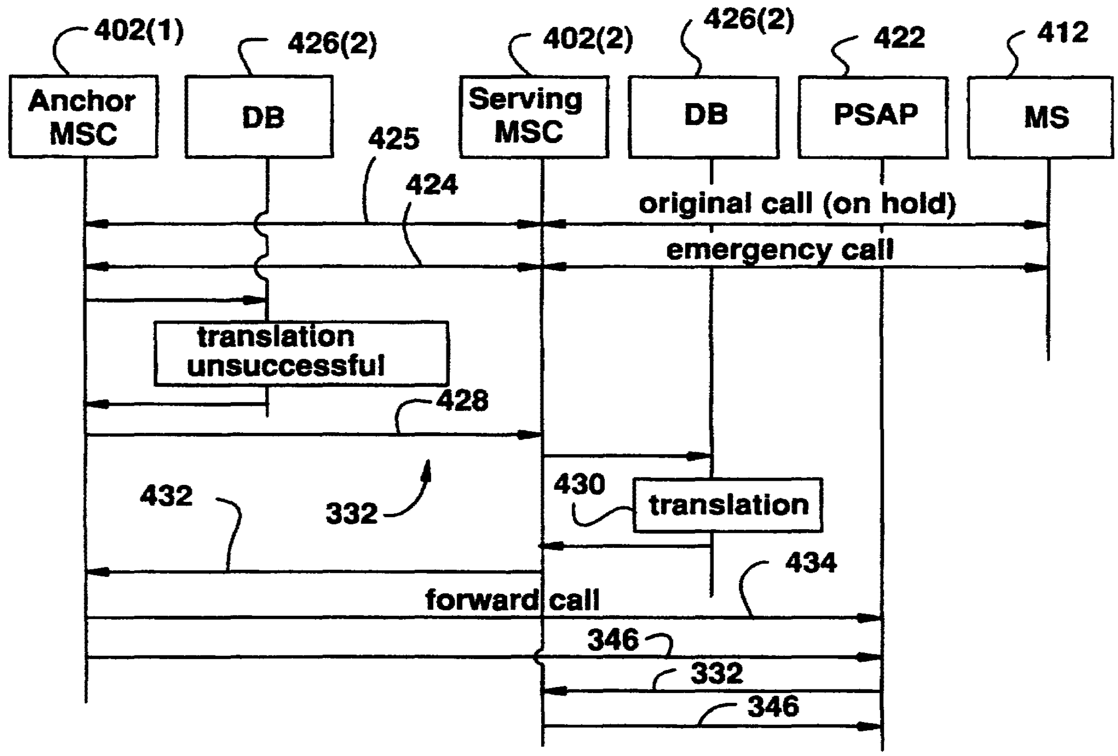
354
342
360
358
360
338
Determine position
342
362
364
Authenticate
346
Authorize
366
342

# FIG.14


402(1)
426(2)
402(2)
426(2)
422
412
Anchor MSC
DB
Serving MSC
DB
PSAP
MS
425
424
original call (on hold)
emergency call
translation unsuccessful
428
432
332
430
translation
434
forward call
346
332
346

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(71) Applicant: ERICSSON INC. [US/US]; 7001 Development Drive, P.O. Box 13969, Research Triangle Park, NC 27709 (US).

(72) Inventors: BOLTZ, David; 901 Loch Ness Lane, Garland, TX 75044 (US). MAUPIN, Alain, Guy; 1133 Lookout Drive, Richardson, TX 75080 (US). MAO, Xiaohong; 2400 Waterview Parkway #424, Richardson, TX 75080 (US).

(74) Agents: MOORE, Stanley, R. et al.; Jenkens & Gilchrist, P.C., Suite 3200, 1445 Ross Avenue, Dallas, TX 75202 (US).

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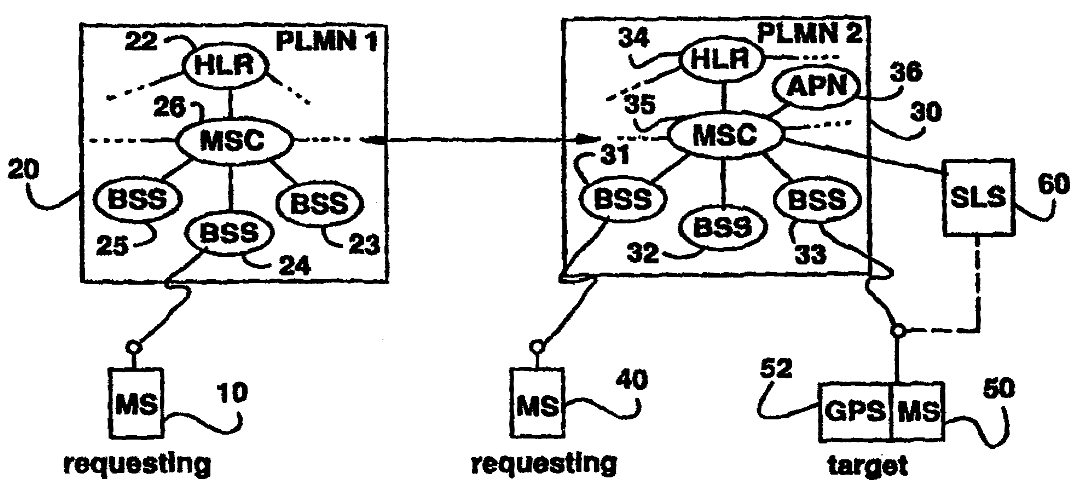


(57) Abstract

Position information regarding a mobile station is determined and provided upon request. In one situation, mobile station position is determined in response to a request from another mobile subscriber (10, 40) and displayed (226) on the requesting mobile station display. Mobile station position is also determined in response to a request from a land line user (70) and provided through either a synthesized voice communication (233), a data message (225) or a facsimile message (237). Mobile station positions are further provided in response to law enforcement (320) and other public service entity (422) requests. This information is useful in tracking a mobile station (312, 412) either during a call or when the mobile station is idle. In another instance mobile station location information is used to insure routing (434) of emergency (911) calls (424) to the proper public safety answering point (422). The system further has the capability of being programmed with certain response criteria applicable to the determination of mobile station position. Such criteria include accuracies, confidence factors, periods between location reports, and location determination technique.

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# INTERNATIONAL SEARCH REPORT

Inter )nal Application No
PCT/US 97/11656

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q G08G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 17 February 1998 | 13/03/98 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Janyszek, J-M |

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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## INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 97/11656

**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. claims 1-25:
Method for routing position information on a target mobile subscriber roaming through a mobile network to and from a requesting second subscriber
2. claims 26-36:
Method for emergency call processing for a roaming mobile subscriber

1. ☒ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (1)) (July 1992)

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**A1**

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(30) **Priority Data:**
08/690,253 24 July 1996 (24.07.96) US

(71) **Applicant:** BELL COMMUNICATIONS RESEARCH, INC. [US/US]; 445 South Street, Morristown, NJ 07960-6438 (US).

(72) **Inventors:** ELY, Thomas, Chambers; 1178 Delaware Drive, Bridgewater, NJ 08807 (US). MARTIN, Michael, A.; 1 Westbrook Avenue, Hillsborough, NJ 08876 (US). NOVAK, Thomas, S; 117 Hockenbury Drive, Glen Gardner, NJ 08826 (US). SMYK, Darek, A.; 15 Zirkel Avenue, Piscataway, NJ 08854 (US).

(74) **Agents:** YEADON, Loria, B. et al.; c/o International Coordinator, Room 1G112R, 445 South Street, Morristown, NJ 07960-6438 (US).

(81) **Designated States:** CA, CN, JP, KR, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

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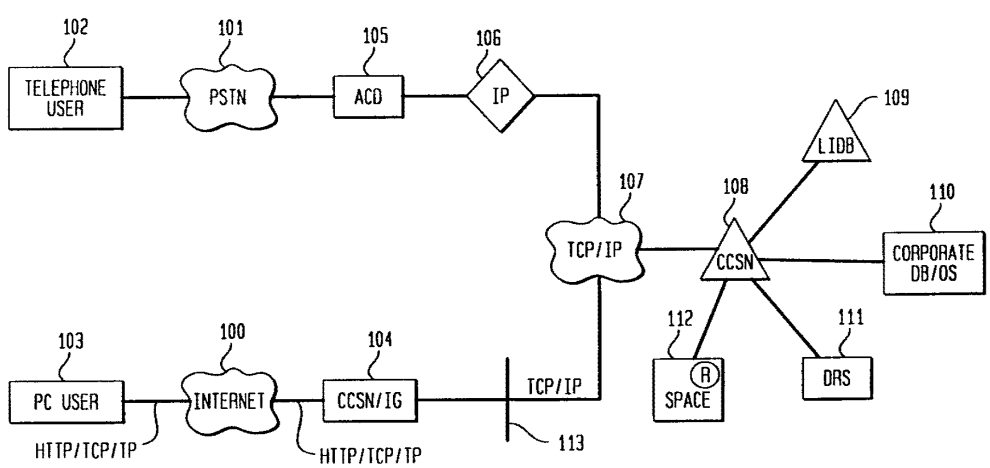
(54) **Title:** SYSTEM AND METHOD FOR PROVIDING CUSTOMER CONTACT SERVICES THROUGH A CUSTOMER CONTACT SERVICES NODE/INTERNET GATEWAY




(57) **Abstract**

A customer contact service node/Internet gateway (CCSN/IG) (104) connects a user (103) to the services and to information from a provider (108) via Internet (100). The user (103) can thereby get information about the services and can initiate service changes and can get user-specific information.

*(Referred to in PCT Gazette No. 21/1998, Section II)

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# SYSTEM AND METHOD FOR PROVIDING CUSTOMER CONTACT SERVICES THROUGH A CUSTOMER CONTACT SERVICES NODE/INTERNET GATEWAY

## Cross Reference to Related Application

This application is related to U.S. Patent Application 08/594,749, entitled "System and Method for Integrating ISCP and Internet Services," filed January 31, 1996 by Darek A. Smyk, the contents of which are incorporated by reference.

## Background of the Invention

The present invention relates generally to telecommunication networks and more particularly to the Internet and Internet services.

Currently, many companies provide call center automation systems and services, such as automatic call distributors, interactive voice response (IVR) systems, coordinated voice and data delivery, and voice mail. Growth in the use of such systems and services is expected to continue. While these technologies provide successful solutions to certain customer demands, they do have some limitations. For instance, callers interacting with an IVR self-service system can only be given a limited set of options at any point because of the tendency of people to become frustrated by long lists of options. Also, effectively communicating large amounts of data over the telephone can be difficult. For example, providing a customer with a line-by-line billing record over the telephone is typically not feasible. Additionally, communicating certain types of common data, such as names and addresses, or other alphanumeric data, requires specialized hardware to perform speech recognition and speech synthesis.

The recent explosion in the use of the Internet provides many new business opportunities and presents significant opportunities to providers of traditional network services. The number of Internet users is growing exponentially, stimulating network service providers to create new services to capture this new market. It is estimated that by 1999, 14 million households will subscribe to Internet access services. This number, however, reflects only a portion of the total number of Internet users because many people have access to the Internet through their school or place of employment. In fact, the current number of Internet users is estimated to be 30 million. The debut of the Microsoft Network service with full Internet access and the addition of Internet access to online services such as Prodigy, CompuServe, and America Online can be expected to bring even more potential customers online. It is projected that use of the Internet will continue to rise and therefore it is desired to provide customer services and access to information to Internet users.

One successful and widely publicized portion of the Internet is the World Wide Web (WWW or the Web). At a conceptual level, the WWW can be thought of as a vast, hyperlinked bank of data. To gain access to the WWW, a user must install on his/her computer WWW browser software and transmission control protocol/Internet protocol (TCP/IP) software and obtain a network connection from an Internet access provider. Once connected to the WWW, a user utilizes the browser to display "home pages"--graphical representations of information stored on WWW servers connected to the Internet.

WWW home pages include "hot links," which are usually represented by the browser as underlined text or as special graphical elements. When a user viewing a home page clicks on one of the hot links, the browser retrieves from the WWW network a home page associated with the selected link. Linked pages may be retrieved from the same or different servers. The sources of linked pages are transparent to the user. Thus, when navigating links between WWW pages, a user gets an impression of dealing with a single, interconnected "web" of information.

As currently implemented in the WWW, each hot link included in a Web document is assigned an address called a Uniform Resource Locator (URL). The URL includes: 1) a protocol indicator; 2) the address of the Internet server on which a particular document resides (generally this address is specified as the Internet domain name of the host or the host IP address); and 3) the address of the document on the server (this address generally consists of a full file name, including a directory path, of the file which contains the document). For example, in URL:*http://www.bellcore.com/aboutbell2.html*, "*http*," which stands for hypertext transfer protocol, identifies the protocol used between browsers and the Web servers; "*www.bellcore.com*" corresponds to the address of Bellcore's (the present assignee) Web server; and "*aboutbell2.html*" identifies the document.

Many companies have home pages that may be accessed in the above manner and that allow Internet users to get more information regarding companies. However, many corporate home pages are still in their infancy. Most provide only generic, non-customer specific information. Additionally most corporate home pages do not permit customers to make queries, get customer-specific information or to make changes to their service. Adding these capabilities would create a more personalized and dynamic exchange with existing or potential customers. Interactions could be custom tailored and product advertisements could be made user specific based on customer profiles or other data stored in corporate databases. Additionally, allowing Internet users to directly access information, products and services would allow for closing sales with customers who have become interested due to the product literature available from the home page. This potential may be lost when the home page is not integrated with the corporate systems that allow access to such products and services.

Some companies have started linking their home pages to their corporate systems. This is typically done by building point to point interfaces between the Web server and the corporate systems. This can be costly, however, particularly when compared to the potential for reuse of existing interface implementations currently in place in IVR systems. Such interfaces can also make it difficult to ensure consistency in customer interactions across a company's various channels, and make it difficult to obtain an overall view of the effectiveness of each channel.

Another current solution for linking home pages and corporate systems is electronic mail, or e-mail. However, e-mail normally requires staff to review the e-mail requests, apply business rules to determine if the requests are appropriate, input the request into the correct corporate system, and respond to the customer. These many steps restrict the advantages of automation.

Currently, Pacific Bell offers services over an agentless, telephone based Electronic Channel New Product Line (ECNPL). ECNPL call volume is projected to increase markedly. Such electronic interactions, as compared to interactions via traditional access methods, for example, over the telephone with an agent, emphasize improved operational efficiency, high availability, reliability, and security. Additionally, using ECNPL, it is often possible to decrease the activation interval or provide immediate activation for changes in service.

However, some self-service offerings are difficult to provide through a telephone interface such as ECNPL. Such offerings may become more feasible using the powerful graphical interface of the WWW. For instance, many advanced intelligent network (AIN) services, such as Do-Not-Disturb and Follow-Me services are cumbersome to instantiate and administer through a telephone channel.

It is therefore an object of the present invention to provide a customer contact services node Internet gateway (CCSN/IG) that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

It is desirable to provide a CCSN/IG by which a user can access a provider's information and services via the Internet.

It is additionally desirable to enhance a provider's existing Internet and home page capabilities to include more complex transactions.

It is also desirable to provide a common toolset for implementing business rules and data access which will leverage the equipment and experienced staff already involved in service creation via an ECNPL.

It is further desirable to provide a common toolset for tracking and reporting on various aspects of a company's customer care offerings including integrating data across the different channels.

Additional objectives, features, and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by means of the instrumentalities and combinations particularly pointed out in the written description and appended claims hereof, as well as the appended drawings.

## Description of the Invention

According to the present invention, a provider's services and customer-specific information are easily and effectively marketed, provided, and administered off of the provider's home page. Wireless and broadband services may be provided as well.

The WWW-based "customer care" channel of the present invention is an effective complement to a telephony channel and the present invention envisions a set of WWW customer contact services similar to today's AIN customer contact services. In addition to providing a complement to a telephone-based self-service channel, such as ECNPL, according to the present invention, a customer contact service node Internet gateway (CCSN/IG) expands the capabilities available through a company's home page by allowing Internet users to not only get customer-specific information and information about available services, but to access and update customer-specific data. In that way, users, for example, access a company's home page and get user-specific information, order services, update or change existing services, or disconnect from services. At the same time, the company can get information about its customers and the services and information desired by its customers. In this way, the company could respond to its customers needs and offer new and different services and information as appropriate.

As an example, in the telephony industry, the CCSN/IG of the present invention allows users to access self-service offerings such as 900/976 call blocking, custom calling, custom local area signalling services (CLASS), inside wire repair plan, and residential optional calling plans. Additionally, the CCSN/IG allows for easy administration of personal identification number (PIN) changes and for the administration of complex services, such as Do Not Disturb and Follow Me. Users will also be able to access customer-specific information, such as billing data and services data. The CCSN/IG allows providers to get information about its customers by providing questionnaires and profiles and could receive customer complaints and/or comments in general.

The CCSN/IG of the present invention complements other telephone based ECNPL self-service offerings by providing similar services to other market segments while reusing the embedded base of systems and interfaces that are currently used in telephony-based self-service offerings. It is envisioned that companies will be able to leverage their existing operational systems that are utilized to provide ECNPL in providing a CCSN/IG. Thus, the overall cost and time of providing products and services to Internet users is small.

From a marketing perspective, providing access to services and information via the Internet makes the company's products and services more readily available and therefore will help promote those products and services, educate users and increase sales. Additionally, processing customer requests via a self-service channel costs significantly less as compared to processing such requests via an agent. Furthermore, compared to the relatively high costs associated with interactive voice recognition (IVR) ports, voice recognition boards, and the other components of a self-service channel with a telephone-based user interface, a self-service channel with an Internet-based user interface that is front-ended by the Internet can drive the cost per transaction significantly lower. Additionally, sizing telephony hardware resources to meet required service level objectives during peak demand periods makes cost of the telephone system higher. For example, at the beginning and the end of college semesters, the demand for telephone services may be great. Offering a software-based solution, such as Internet access, provides a cost-effective solution. This is particularly so in the example above because many of those requesting service connection or disconnection would have access to the Internet.

Additionally, new services and products can be offered to users without delay because the provider's home page can be easily changed to allow access to and selection of such new products and services.

Thus, the CCSN/IG of the present invention provides a gateway between a provider's WWW home page and its information and services and also provides a single platform for all customer care access methods. The present invention also advantageously provides the opportunity to immediately offer self-service options on the WWW that parallel those offered through an ECNPL.

Additionally, the CCSN/IG of the present invention advantageously provides an integrated platform for development, operations, administration and reporting as well as the ability to leverage previous investments in systems, interfaces, networks and staff. Specifically, the CCSN/IG of the present invention allows a provider to leverage its existing operations support systems (OSS) rather than incurring these costs again. As new OSS interfaces are incorporated into the CCSN architecture, the cost of developing these interfaces is incurred once, rather than being repeated for each customer care channel.

An additional benefit of the present invention is that the CCSN/IG of the present invention can be used with existing applications, such as Bellcore's proprietary SPACE® application and the data and reporting system (DRS) to provide an integrated view of the interactions taking place over the Internet and across the traditional telephone interface.

To achieve these and other advantages and in accordance with the purposes of the invention, as embodied and broadly described, the invention includes a customer contact services system comprising means for accessing the Internet, means for entering a request, means for displaying the request, customer contact services node Internet gateway (CCSN/IG) means, coupled to the display means and to the Internet, for accepting the request, network means, coupled to the CCSN/IG means, for providing access to a particular set of services and data, and customer contact services node (CCSN) means, coupled to the network means, for processing the request and for providing information about the request through the network means and the CCSN/IG means to the display means.

In accordance with the purposes of the invention, as embodied and broadly described, the invention also includes a method for user access to data and services of a provider comprising the steps of accessing a network, entering a request, displaying the request, accepting the request via a customer contact services node network gateway, providing access to a particular set of data and services of the provider, and processing the request and providing information about the request through the network and the customer contact services node network gateway.

It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

Brief Description of the Drawings

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate presently preferred implementations of the invention and, together with the general description given above and the detailed description of the preferred implementations given below, serve to explain the principles of the invention.

In the Drawings:

Fig. 1 is a block diagram of a customer contact services system in accordance with one embodiment of the present invention;

Fig. 2 is a block diagram showing in greater detail the customer contact services system in accordance with one embodiment of the present invention;

Fig 3 is a block diagram showing in greater detail the corporate database and operations system shown in Fig. 2 in accordance with one embodiment of the present invention;

Figs. 4A-4E are exemplary screens illustrating how a user interfaces with a customer contact services system in accordance with one embodiment of the present invention;

Fig. 5 is a flow diagram showing how a service request is made using the customer contact services system in accordance with one embodiment of the present invention; and

Fig. 6 is a flow diagram illustrating exemplary steps taken during an interface with a customer contact services system in accordance with one embodiment of the present invention.

Best Mode For Carrying Out the Invention

Reference will now be made in detail to the construction and operation of preferred implementations of the present invention which are illustrated in the accompanying drawings. In those drawings, like elements and operations are designated with the same reference numbers where appropriate.

The following description of the preferred implementations of the present invention is only exemplary of the invention. The present invention is not limited to these implementations, but may be realized by other implementations.

Fig. 1 is a block diagram of an integrated Internet system in accordance with one embodiment of the present invention. As shown, a PC user 103 is connected to the Internet 100 via the HTTP/TCP/IP protocol. Although a PC user 103 is shown in Fig. 1, the present invention is not so limited. Instead of using a PC, a user could access the Internet via a Unix workstation, a wireless personal digital assistant, or any other type of device used to access the Internet. The Internet 100 communicates with the CCSN/IG 104 also via the HTTP/TCP/IP protocol. The CCSN/IG 104 provides a gateway interface between the PC user 103 and a provider's customer contact services node (CCSN) 108. The CCSN/IG 104 runs standard HTTP server software that accepts an HTTP request from the PC user 103 over the Internet 100. The CCSN/IG 104 communicates with a network 107 using the TCP/IP protocol. Interposed between the CCSN/IG 104 and the network 107 is a "firewall" 113, which prevents the PC user 103 from gaining unauthorized access to files and applications in the network 107.

The network 107 is also connected to the CCSN 108 via the TCP/IP protocol, or any other appropriate protocol. The CCSN 108 runs applications, such as Bellcore's proprietary SPACE® application 112. The SPACE® application 112 is used to create business rules for interacting with customers and has been successfully implemented in telephone service control points (SCP) to efficiently create and instantiate telephone services. The SPACE® application 112 generates call processing records (CPR) and stores them in a database, not shown, associated with the CCSN 108.

The CCSN 108 is also connected to the line information database (LIDB) 109. The LIDB 109 contains information regarding telephone service subscribers. It may be keyed by the billing telephone number of the user 103 and retrieves information about particular accounts. More specifically, the LIDB 109 contains information essential for making collect calls, calls billed to third numbers, and calls charged to calling cards. The LIDB 109 is used to automatically verify that the telephone number to which a person wants to bill a collect or third-number call has been assigned and can be charged for such calls. The LIDB 109 also validates the personal identification number (PIN) assigned to each calling card.

The CCSN 108 is also connected to the corporate database and operations system 110, which is used to support the operations and applications of the CCSN 108, such as interactions with customers and customer billing. The CCSN 108 is also connected to the data and reporting system (DRS) 111. The DRS 111 may be used to collect information on customer interactions taking place via the

CCSN 108. Thus, information gathered about a PC user 103 who accesses the CCSN 108 can be collected by the DRS 111. Additionally, information provided by such users, such as in response to questionnaires, can be stored and maintained in the DRS 111.

The integrated Internet system as shown in Fig. 1 also allows a telephone user 102 to access the network 107 and the CCSN 108. Access to the CCSN 108 for a telephone user 102 is accomplished via public switched telephone network (PSTN) 101, automated call distributor (ACD) 105 and intelligent peripheral (IP) 106. These elements comprise an IVR system by which a user can access information and services, made available through the CCSN 108, in a self-service or agentless fashion. Alternatively, a telephone user 102 can access the provider's services and products with the assistance of an agent, if necessary.

As illustrated in Fig. 1, the CCSN/IG 104 can be thought of as an add-on to existing systems that allow access to a CCSN 108 by a telephone user 102. In this manner, one customer contact system may be implemented for both access methodologies using the same set of rules and logic as well as using the systems previously in place for the telephone system.

Fig. 2 is a block diagram showing in greater detail the CCSN/IG system in accordance with one embodiment of the present invention.

As shown in Fig. 2, the CCSN/IG 104 comprises a Web server 201 and an integrated service control point (ISCP) gateway 202. The Web server 201 corresponds to a conventional Internet server, such as Webstar from Quarterdeck Corp. or Netscape Communications Server from Netscape Communications Corp. The Web server 201 communicates with the Internet 100 via the HTTP/TCP/IP protocol. To communicate on the Web, the PC user 103 must be running a Web browser application, such as Netscape's Navigator or Microsoft's Internet Explorer, which supports hyperlinks based retrieval of documents stored in Web files 203 any place on the Internet 100. The Web files 203 may include documents in hypertext markup language (HTML), that may contain graphics, video, and sound, and which may be linked to other documents.

The ISCP gateway 202 implements the application function of the gateway. In general, the ISCP gateway 202 responds to user queries forwarded by the Web server 201 by returning HTML templates augmented with the data retrieved from back-end systems, such as the ISCP and the systems that the ISCP interfaces with. The ISCP gateway 202 interacts with the Web server 201 utilizing the interface of the Web server 201. This interface may be, for example, the common gateway interface (CGI) 204, shown in Fig. 2. The CGI 204 is used to communicate between the Web server 201 and the applications that can service the PC user's 103 request. Instead of the CGI 204, the server interface can be NSAPI when the Netscape Web server is used or ISAPI when the Microsoft Web server is used.

Fig 3 is a block diagram showing in greater detail the elements of an exemplary corporate database and operations system 110 in accordance with one embodiment of the present invention. It should be noted that the elements of corporate database and operations system 110 will differ depending on the corporate system which the user 103 accesses. The elements of the corporate database and operations system 110 shown in Fig. 3 are exemplary of a telecommunications provider.

The CCSN 108 is connected to the elements of the corporate database and operations system 110 via a wide area network 310. The wide area network 310 is directly connected to various database and operations systems as described in greater detail below.

The AP 301, connected to the wide area network 310, is an operations system used to activate and or modify services for a user 103. Thus, when user 103 wants to modify his services, the service request is sent to the AP 301 operations system. The LMOS 302 is an operations system used to provide service assurance. Such service assurance can include, for example, trouble reporting, testing, and fault isolation. The BOSS 303 is an operations system used to maintain customer billing and payment information.

The CCPL 304 is a gateway system used to provide access to the various operations systems 306-309. The CCPL 304 also performs protocol conversions and maintains any local databases. The CCDL 305 is such a database within the CCPL 304 and is used to store temporary miscellaneous corporate data such as temporary pricing plans for current promotional campaigns.

The PBP 309 is an operations system that provides customer verification and authentication services. An exemplary service could be personal identification number (PIN) validation. The PREMIS system 308 is an operations system used to maintain and validate the location of customers. For instance, PREMIS 308 can be used to maintain the street addresses of customers. The AOG 307 is an operations system used to maintain information regarding pending customer service activation requests. Finally, the MI 306 is an operations system used to maintain for each customer a profile of the services used by that customer.

The corporate database and operations system 110 also may include an agent station 311. Instead of accessing any of the operations systems 301-303 or 306-309, the user 103 can, in alternative embodiments, interface with the agent station 311. The agent at the agent station 311 will work at an appropriate desktop device such as a PC, a workstation, a 3270 terminal, or any other appropriate device.

According to the present invention, an Internet interface through a CCSN/IG to a provider's home page could be used to allow customers to order or discontinue services or to get customer-specific information. For instance, in a telecommunications application, the CCSN/IG of the present invention could allow customers to order certain telephone services or disconnect from services over the Internet. By permitting service connection/disconnection in this manner, it is envisioned that backlogs or the need to use a greater than normal number of service operators during peak service connect/disconnect periods, such as the beginning and end of school years, would be eliminated. Figs. 4A-4E are exemplary screens illustrating how a user interfaces with the customer contact services system in accordance with one embodiment of the present invention.

Fig. 4A shows an example of a provider's home page according to the present invention. A PC user 103, shown in Figs. 1-3, could access this screen, or one like it, through the Internet 100 and the CCSN/IG 104 of the present invention. As shown in Fig. 4A, the user could first get information about the service features of the provider. For instance, where the provider is a telecommunications company, the user could access information about call forwarding 401, call screening 402, call waiting 403, select call forwarding 404, and speed calling wait 405. By selecting one of the options 401-405, the user can access information such as general information about the service, and the cost of the service. Selecting one of the options 401-405 will bring up another screen, not shown, which will display specific information about the requested service.

As also shown in Fig. 4A, the user can select to order or cancel any of the available service features 401-405 by selecting the order/cancel option 406. Selection of the order/cancel option 406, will cause the screen shown in Fig. 4B to be displayed. Fig. 4B is a verification screen and requires the user to enter certain information before any requested changes to a service can be made. First, in the case of a telecommunications provider, the user is prompted to enter his telephone number in box 407. After entering the telephone number, the user must enter a password which can be, for example, a certain number of digits of a calling card number 408, an account number 409, or a PIN number 410. After the telephone number and password have been entered, the user selects the submit key 411 and proceeds on to the service modification screen shown in Fig. 4C.

The service modification request screen in Fig. 4C can first display the account number and name of the person seeking to modify their service in box 412. Fig. 4C also shows table 413 showing service features that are available to the user. The service features can be different for different users, depending on the geographic availability of services for particular users. Table 413 indicates whether a particular service feature is currently subscribed to. For service features that are currently subscribed to, such as call waiting and speed calling eight, shown in table 413, the user can select to cancel such services, while for service features that are not currently subscribed to, the user can elect to order such services. Additionally, for all service features listed in the table 413, the user can elect no change to each current service feature. When the user is finished making his desired service modifications, he will depress the submit box 414. In addition, if the user wants to abort any of the service changes, he can select the cancel box 415. Instructional text may be inserted at the ellipses 420.

If the user selects to change his service, the order verification screen of Fig. 4D preferably appears. The order verification screen displays a subscription status table 416 which lists the subscription status of all of the available service features after any changes have been made. The order verification screen can also optionally display the service charges that will be billed to the user as well as any other appropriate messages about the user's account or services. Such information, or other instructions may appear at ellipses 420. After the user reviews the subscription status table 416 and any other information provided, the user will accept the service changes by selecting the confirm box 417. If, however, after reviewing the subscription status table 416 and the other information provided to the user, the user decides that the service modifications are not acceptable, the user can abort the changes to service by selecting the cancel box 418.

If the user selects the confirm box 417, a confirmation screen, such as that shown in Fig. 4E, may appear. The confirmation screen will, for example, inform the user that the service modifications have been accepted for processing and when the service changes will be made at ellipses 420. Additionally, the confirmation screen may advise the user that he will receive a separate confirmation by mail. The confirmation screen could also be configured to inform the user that a separate confirmation of the service modifications will be sent by e-mail. Also at the confirmation screen, the user can return to the provider's main page by selecting the main page box 419.

As described above, Figs. 4A-4E are exemplary screens that can be displayed when a user accesses a provider's services through the CCSN/IG of the present invention. The screens provided to the user will differ depending on the services made available by the provider. Additionally, the screens a specific provider makes available can differ depending on the particular users. For example, different screens can be made available to an individual account holder as opposed to a small business account.

Fig. 5 is a flow diagram showing how a request is made using the customer contact services system in accordance with one embodiment of the present invention. As shown in Fig. 5, a user first accesses the Internet in step 501. Included within step 501 is the step of accessing information about a particular service provider. This may be accomplished by accessing the home page of a service provider. Following access to information about the service provider, the user enters a request in step 502. As explained above, such a request could for example be a request to add an additional telephone service, or change a telephone service, or to receive customer-specific information. The present invention, however, is not so limited and also could include a request regarding ordering merchandise from a retailer, for example. After the request is entered in step 502, it is displayed to the user in step 503. The request is displayed so that the user can modify the request before it is sent to the provider. The request is then accepted by the provider in step 504. After the request is accepted, the provider provides information about the request to the user in step 505. The information provided to the user can be that a change in service, such as an addition or cancellation of service, has or will be processed by the provider, for example. Alternatively, the information could be the customer-specific information, such as billing data, requested by the user. In order for the provider to send such information to the user, it may be necessary for the provider to access its own databases and/or operations systems, as shown in Figs. 1-3.

Fig. 6 is a flow diagram illustrating exemplary steps taken during an interface with a customer contact services system in accordance with one embodiment of the present invention. In step 601, the user accesses the provider's services, and a home page screen, such as that shown in Fig. 4A, may appear. Next, in step 602, the user decides whether he wants to get any information about the provider's services. If yes, the information is provided in step 603. If the user does not want any additional information, then he proceeds to step 604 where he decides whether he wants to order or cancel any of the provider's services. If the user does not want to order or cancel any services, in step 605, the user decides if he wishes to exit from the provider's services, if not, the user is returned to step 602 and if so, the user is exited at step 606.

When the user wants to order or cancel services, at step 607 information identification, such as a user identification and a password, is inputted. At step 608, the user is verified if the correct identification information was entered. If not, the user is exited at step 606. If the user is verified, then at step 609 the user enters the desired service changes. The user confirms whether the entered service changes are correct at step 610. If the changes are not correct, the user can correct the changes at step 609. If the changes are correct, the changes are entered. Confirmation of the service changes is made at step 612. If the user is done accessing the provider's services, at step 613 he so indicates and is exited at step 606. If the user is not finished, he is returned to step 602.

It should be noted that the steps shown in Fig. 6 are exemplary only and can differ depending on the type of services provided by the provider and can also differ depending on the type of user.

Although previously discussed in terms of use over the Internet, the CCSN/IG of the present invention can also be used in an "intra-net" or internal Web server used exclusively to service the needs of an individual organization. Estimates indicate that more internal Web servers exist today than external Web servers. These internal Web servers provide a number of advantages when deploying applications for internal use. For instance, browsers already exist for a wide variety of end-user platforms, making the task of cross-platform development and support much easier. Additionally, in an intra-net situation, only the browser is distributed to each desktop while the application resides at a central location thereby making the administration of internal applications much easier. The same browser can be used for many different applications and therefore users do not have to become accustomed to the look and feel of multiple browsers. Also, the powerful presentation capabilities of today's Web browsers allow for creation of appealing and easy to use applications.

There are several additional advantages of such an intra-net system. First, the system administrator of an intra-net system has a great deal of control over who has access to the system and to the particular applications residing in the system. Additionally, there is no need to provide a firewall and the security risks of such a system are much lower than in an Internet system. These lower security risks make the engineering of such a system much easier than in an Internet system.

While there has been illustrated and described what are considered to be preferred embodiments and methods of the present invention, it will be understood by those skilled in the art that various changes and modifications may be made, and equivalents may be substituted for elements thereof without departing from the true scope of the invention.

In addition, many modifications may be made to adapt a particular element, technique or implementation to the teachings of the present invention without departing from the central scope of the invention. Therefore, it is intended that this invention not be limited to the particular embodiments and methods disclosed herein, but that the invention involve all embodiments falling within the scope of the appended claims.

Claims:

1. A customer contact services system comprising:

means for accessing the Internet;

means for entering a request;

means for displaying the request;

a customer contact services node Internet gateway (CCSN/IG), coupled to the display means and to the Internet, for accepting the request;

a network, coupled to the CCSN/IG, for providing access to a particular set of services and data; and

a customer contact services node (CCSN), coupled to the network, for processing the request and for providing information about the request through the network and the CCSN/IG to the display means.

2. The system according to claim 1, wherein the entering means may be responsive to the information provided by the CCSN means regarding the request.

3. The system according to claim 1, wherein the CCSN means comprises means for invoking at least one call processing record (CPR) in response to the request.

4. The system according to claim 1, further comprising interactive voice response (IVR) means, coupled to the network means, for providing telephone access to the network means and for permitting a request to be made over the telephone.

5. The system according to claim 1, wherein the CCSN/IG means further comprises:

a Web server for providing access to the World Wide Web (WWW); and an integrated services control point (ISCP) gateway, coupled to the Web server, for accessing the network means.

6. The system according to claim 5, further comprising a firewall disposed between the ISCP gateway and the network.

7. A method for user access to a services and data of a provider comprising:

accessing a network;

entering a request;

displaying the request;

accepting the request via a customer contact services node Internet (CCSN/IG) gateway;

providing access to a particular set of data and services of the provider; and

processing the request and providing information about the request through the network and the customer contact services node network gateway.

8. The method according to claim 7, wherein the accessing step comprises accessing the Internet.

9. The method according to claim 7, wherein the accessing step comprises accessing an intra-net.

FIG. 1

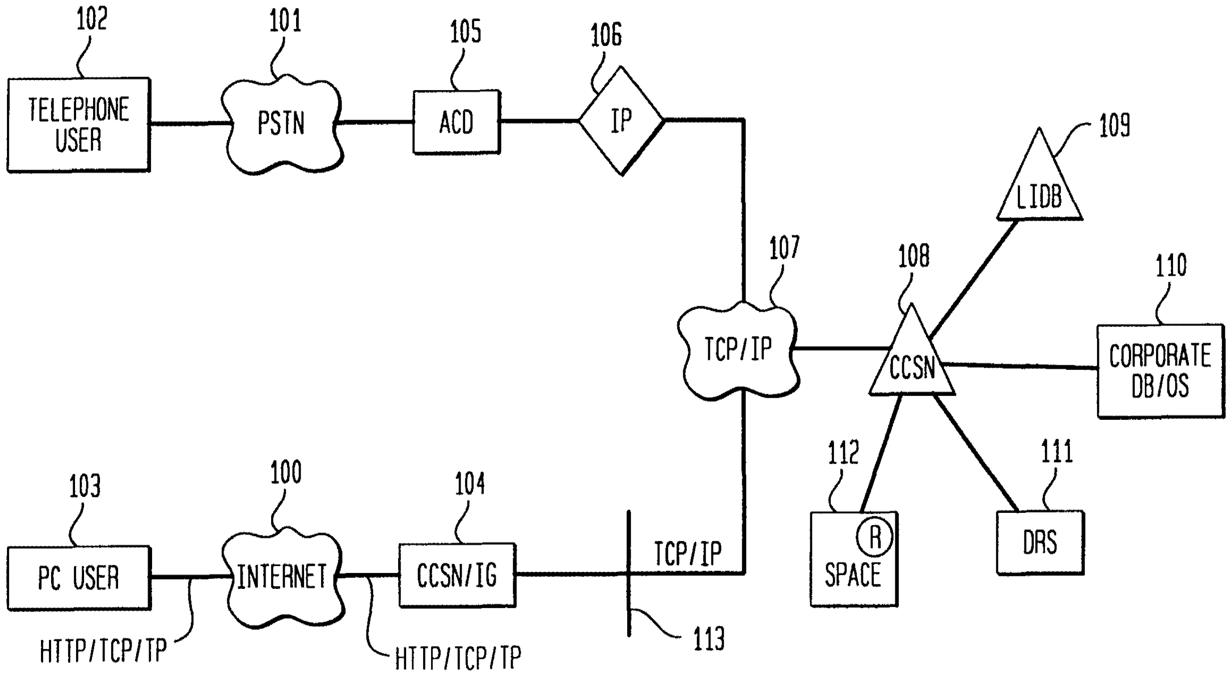

102
101
105
106
TELEPHONE USER
PSTN
ACD
IP
109
LIDB
107
108
110
TCP/IP
CCSN
CORPORATE DB/OS
103
100
104
112
111
PC USER
INTERNET
CCSN/IG
TCP/IP
R
SPACE
DRS
HTTP/TCP/TP
HTTP/TCP/TP
113

FIG. 2

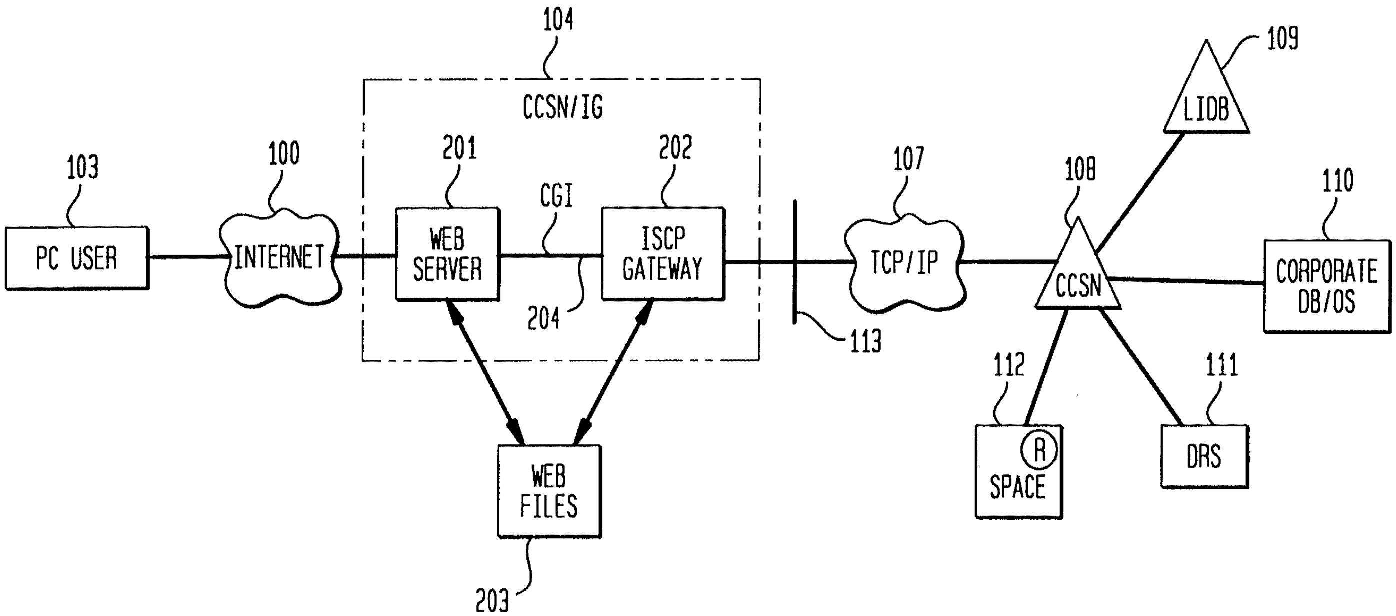

104
CCSN/IG
103
PC USER
100
INTERNET
201
WEB SERVER
CGI
204
202
ISCP GATEWAY
113
107
TCP/IP
108
CCSN
109
LIDB
110
CORPORATE DB/OS
112
R
SPACE
111
DRS
WEB FILES
203

FIG. 3

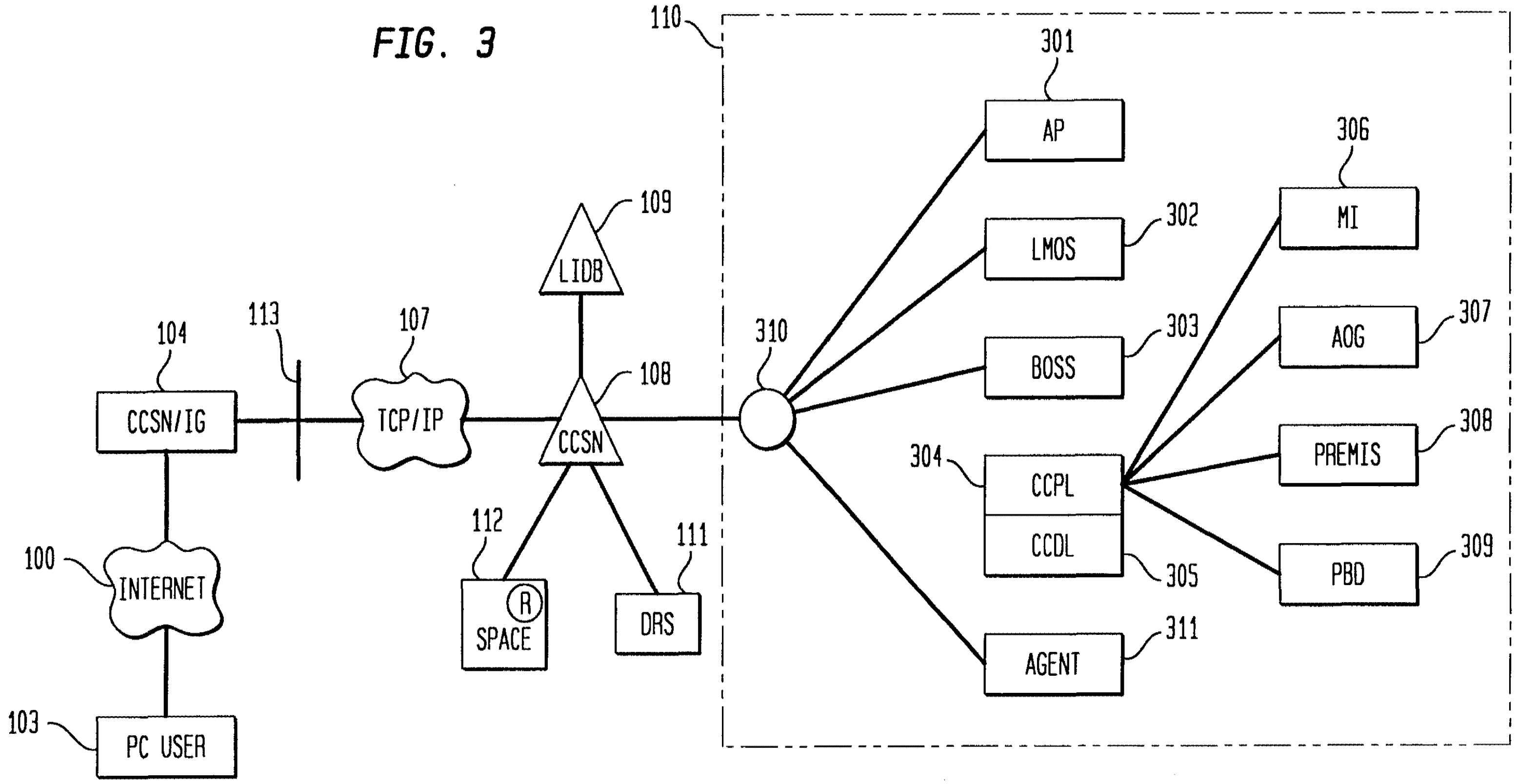

110
301
AP
302
LMOS
303
BOSS
304
CCPL
CCDL
305
311
AGENT
306
MI
307
AOG
308
PREMIS
309
PBD
310
109
LIDB
108
CCSN
107
TCP/IP
113
104
CCSN/IG
100
INTERNET
103
PC USER
112
R
SPACE
111
DRS

FIG. 4A

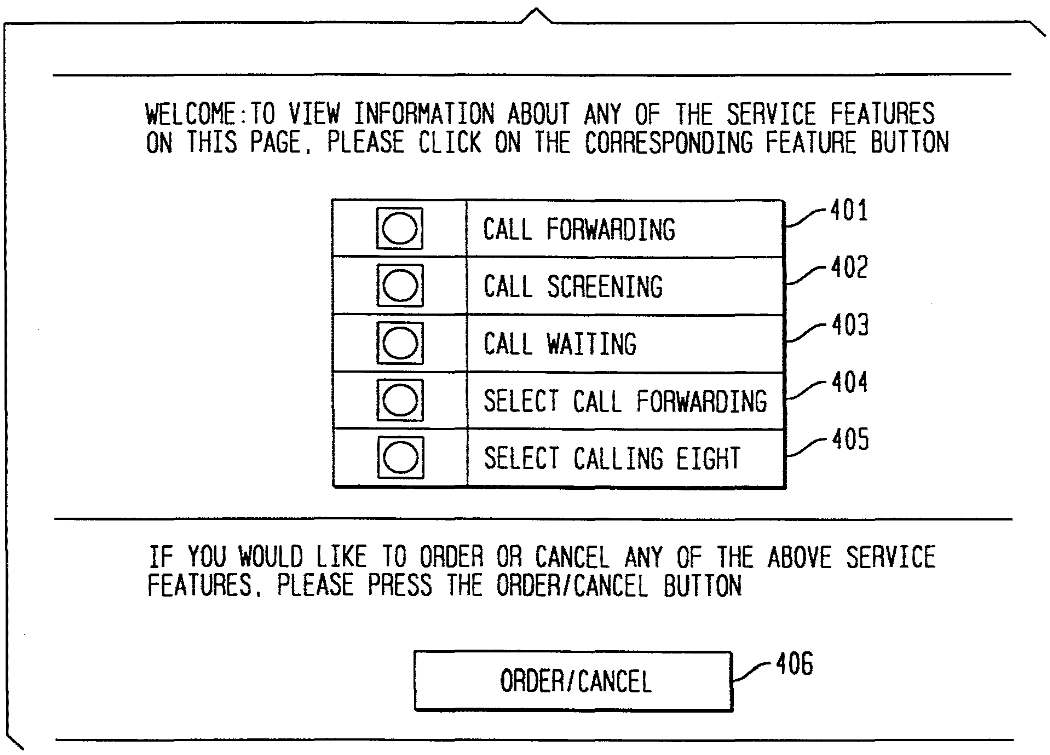

WELCOME:TO VIEW INFORMATION ABOUT ANY OF THE SERVICE FEATURES ON THIS PAGE, PLEASE CLICK ON THE CORRESPONDING FEATURE BUTTON
CALL FORWARDING
401
CALL SCREENING
402
CALL WAITING
403
SELECT CALL FORWARDING
404
SELECT CALLING EIGHT
405
IF YOU WOULD LIKE TO ORDER OR CANCEL ANY OF THE ABOVE SERVICE FEATURES, PLEASE PRESS THE ORDER/CANCEL BUTTON
ORDER/CANCEL
406

FIG. 4B

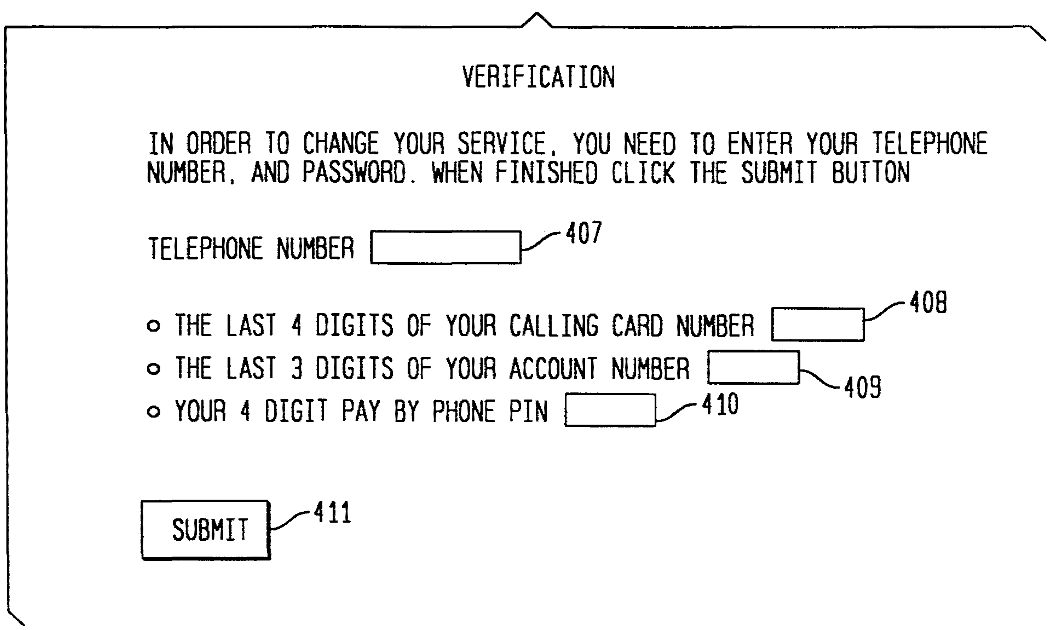

VERIFICATION
IN ORDER TO CHANGE YOUR SERVICE, YOU NEED TO ENTER YOUR TELEPHONE NUMBER, AND PASSWORD. WHEN FINISHED CLICK THE SUBMIT BUTTON
TELEPHONE NUMBER
407
THE LAST 4 DIGITS OF YOUR CALLING CARD NUMBER
408
THE LAST 3 DIGITS OF YOUR ACCOUNT NUMBER
409
YOUR 4 DIGIT PAY BY PHONE PIN
410
SUBMIT
411

FIG. 4C

SERVICE MODIFICATION REQUEST

ACCOUNT (510)811-6150, J.DOE 412

. . . 420

413

| | | CURRENTLY SUBSCRIBED FEATURES | INDICATE DESIRED MODIFICATIONS | | |
|---|---|---|---|---|---|
| | | | ORDER | CANCEL | NOCHANGE |
| | CALL FORWARDING | NO | 0 | | 0 |
| SERVICE FEATURES | CALL SCREENING | NO | 0 | | 0 |
| | CALL WAITING | YES | | 0 | 0 |
| | SELECT CALL FORWARDING | NO | 0 | | 0 |
| | SPEED CALLING EIGHT | YES | | 0 | 0 |

. . . 420

SUBMIT 414

CANCEL 415

. . . 420

FIG. 4D

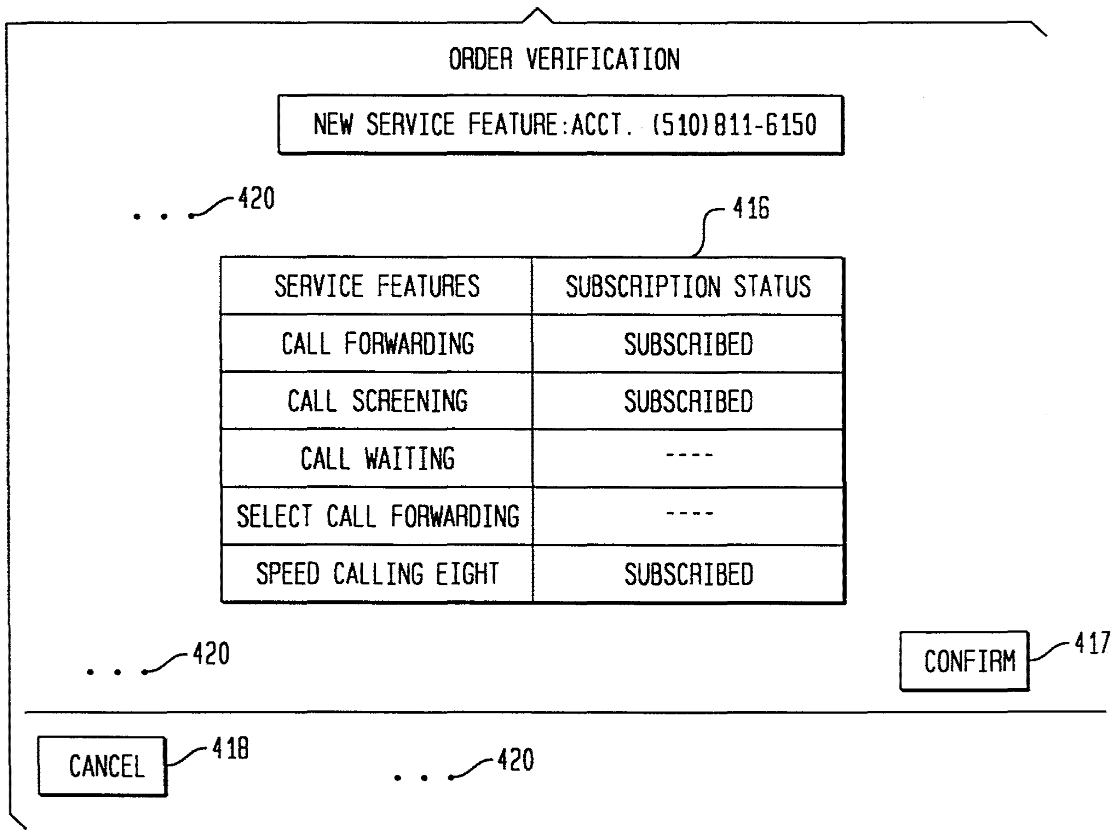

ORDER VERIFICATION
NEW SERVICE FEATURE:ACCT. (510)811-6150
420
416
SERVICE FEATURES
SUBSCRIPTION STATUS
CALL FORWARDING
SUBSCRIBED
CALL SCREENING
SUBSCRIBED
CALL WAITING
----
SELECT CALL FORWARDING
----
SPEED CALLING EIGHT
SUBSCRIBED
420
CONFIRM
417
CANCEL
418
420

FIG. 4E

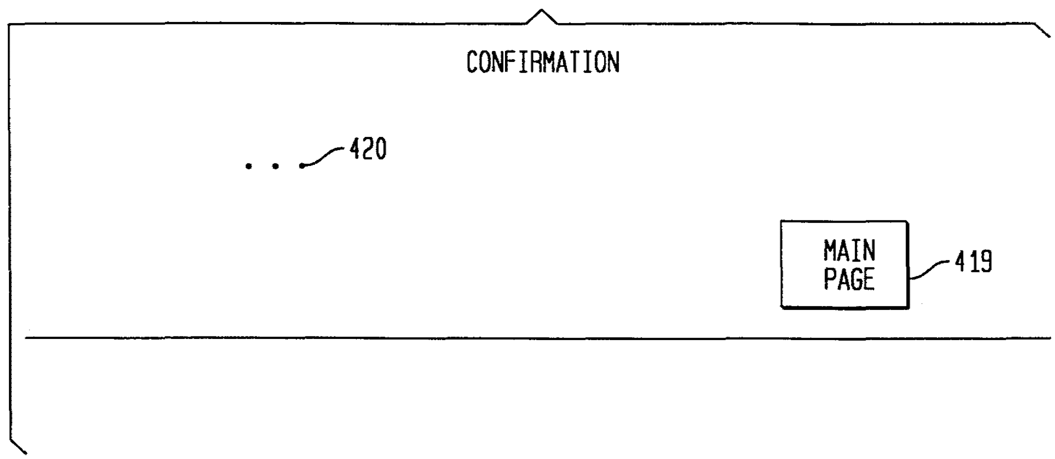

CONFIRMATION
420
MAIN PAGE
419

FIG. 5

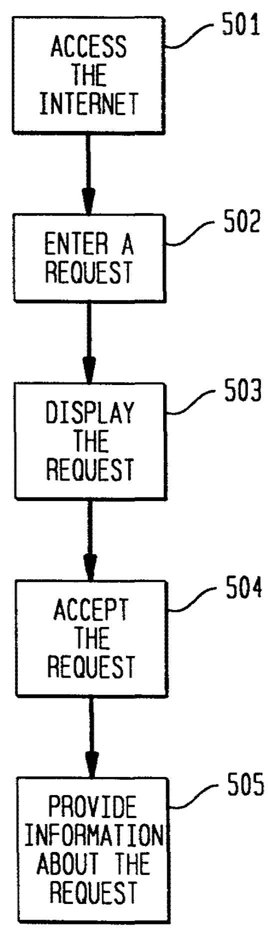
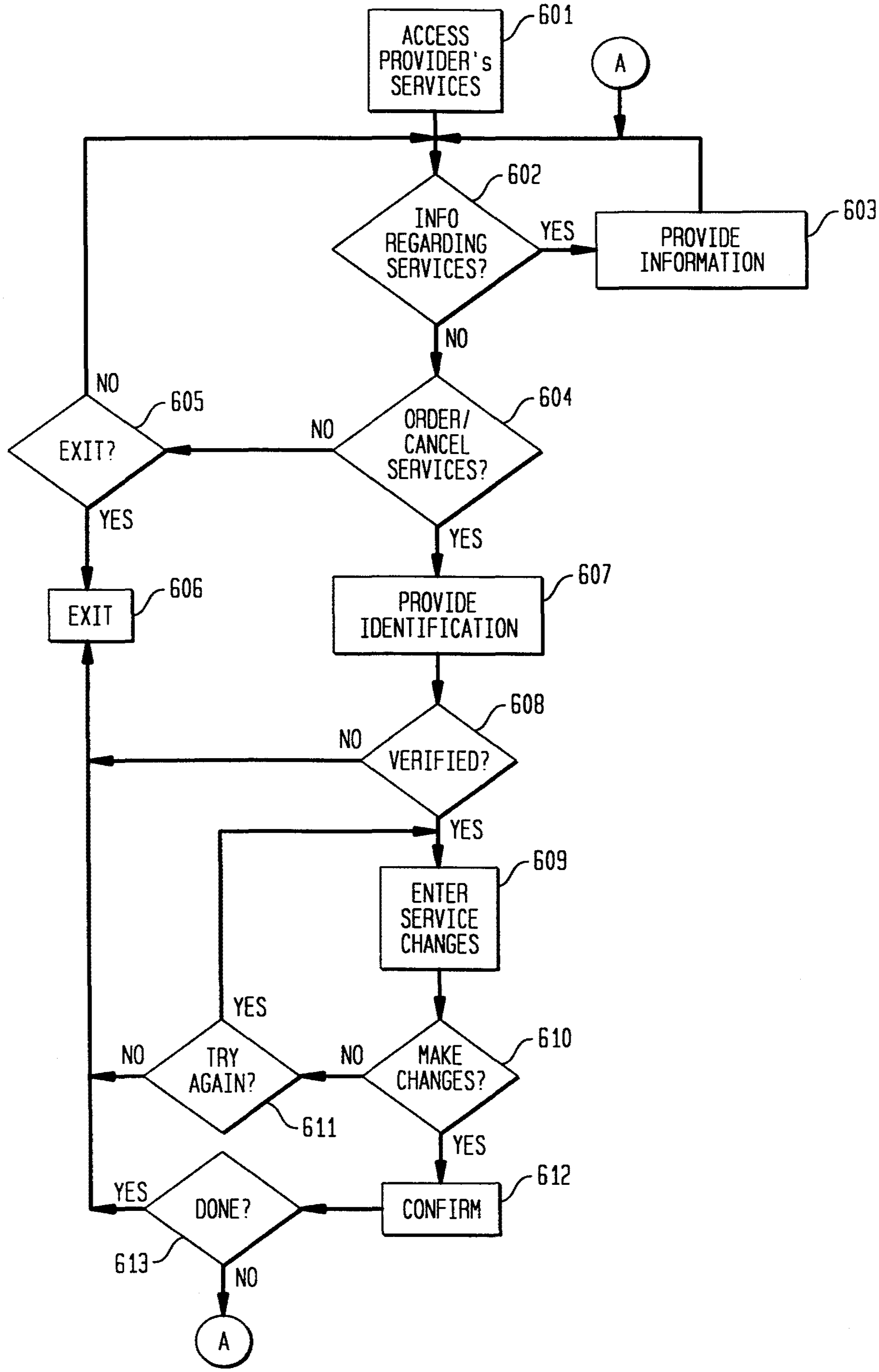

ACCESS THE INTERNET
501
ENTER A REQUEST
502
DISPLAY THE REQUEST
503
ACCEPT THE REQUEST
504
PROVIDE INFORMATION ABOUT THE REQUEST
505

FIG. 6


ACCESS PROVIDER's SERVICES
601
A
INFO REGARDING SERVICES?
602
YES
PROVIDE INFORMATION
603
NO
ORDER/ CANCEL SERVICES?
604
NO
EXIT?
605
NO
YES
EXIT
606
YES
PROVIDE IDENTIFICATION
607
VERIFIED?
608
NO
YES
ENTER SERVICE CHANGES
609
MAKE CHANGES?
610
NO
TRY AGAIN?
611
YES
NO
YES
CONFIRM
612
DONE?
613
YES
NO
A

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/12792

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) :H04L 9/00; H04M 3/42; G06F 11/34, 19/00
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS SEARCH--> Search Terms : customer or client or user, server or provider, network, node, internet gateway (IG), world wide web (WWW), web server

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y,P | US 5,590,197 A (CHEN ET AL) 31 December 1996, see figure 1, column 1 line 64 to column 2 line 7, column 2 lines 39-48, column 4 lines 43-62, column 5 lines 37-41, column 6 line 12 to column 7 line 8, and column 7 lines 38-41. | 1-9 |
| Y,P | US 5,572,643 A (JUDSON) 05 November 1996, see abstract, figures 2-3, column 4 lines 36-51, and column 5 line 41 to column 6 line 12. | 1-9 |
| A,P | US 5,572,581 A (SATTAR ET AL) 05 November 1996. | 1-9 |
| A,P | US 5,553,239 A (HEATH ET AL) 03 September 1996. | 1-9 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
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(71)(72) Applicants and Inventors: LEBLANC, Frederick, W. [US/US]; 7547 Braun Street, Arvada, CO 80005 (US). DuPRAY, Dennis, Jay [US/US]; 222 South Marion Parkway, Denver, CO 80209 (US). KARR, Charles, L. [US/US]; 400 Sandbrook Lane, Tuscaloosa, AL 35405 (US).

(74) Agents: DuPRAY, Dennis, J. et al.; Sheridan Ross P.C., Suite 3500, 1700 Lincoln Street, Denver, CO 80203-4501 (US).

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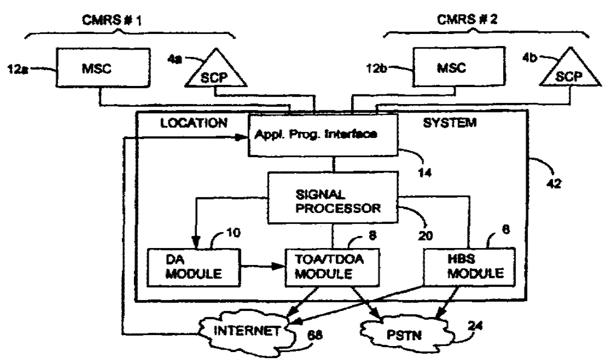


WIRELESS LOCATION USING MULTIPLE CMRSs

(57) Abstract

A location system for commercial wireless telecommunication infrastructures (CMRRs). The system is an end-to-end solution having one or more location systems (42) for outputting requested locations of commercially available hand sets or mobile stations (not shown) based on, e.g, AMPS, NAMPS, CDMA or TDMA communication standards, for processing both local mobile station location requests and more global mobile station location requests via, e.g., Internet communication between a distributed network of location systems. The system uses a plurality of mobile station locating technologies including those based on: two-way TOA and TDOA; home base stations and distributed antenna provisioning. Further, the system can be modularly configured for use in location signaling environments ranging from urban, dense urban, suburban, rural, mountain to low traffic or isolated roadways. Accordingly, the system is useful for 911 emergency calls, tracking, routing, people and animal location including applications for confinement to and from certain areas.

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# LOCATION OF A MOBILE STATION USING A PLURALITY OF COMMERCIAL WIRELESS INFRASTRUCTURES

## RELATED FIELD OF THE INVENTION

The present invention is directed generally to a system and method for locating people or objects, and in particular to a system and method for locating a wireless mobile radio station in a macro base station, distributed antenna, or home base station environment.

## BACKGROUND OF THE INVENTION

Wireless communications systems are becoming increasingly important worldwide. Wireless cellular telecommunications systems are rapidly replacing conventional wire-based telecommunications systems in many applications. Commercial mobile radio service provider networks, and specialized mobile radio and mobile data radio networks are examples. The general principles of wireless cellular telephony have been described variously, for example in U. S. Patent 5,295,180 to Vendetti, et al, which is incorporated herein by reference. There is great interest in using existing infrastructures for wireless communication systems for locating people and/or objects in a cost-effective manner. Such a capability would be invaluable in a variety of situations, especially in emergency or crime situations. Due to the substantial benefits of such a location system, several attempts have been made to design and implement such a system. Systems have been proposed that rely upon signal strength and trilateralization techniques to permit location include those disclosed in U.S. Patents 4,818,998 and 4,908,629 to Apsell et al. ("the Apsell patents") and 4,891,650 to Sheffer ("the Sheffer patent"). The Apsell patents disclose a system employing a "homing-in" scheme using radio signal strength, wherein the scheme detects radio signal strength transmitted from an unknown location. This signal strength is detected by nearby tracking vehicles, such as police cruisers using receivers with directional antennas. Alternatively, the Sheffer patent discloses a system using the FM analog cellular network. This system includes a mobile transmitter located on a vehicle to be located. The transmitter transmits an alarm signal upon activation to detectors located at base stations of the cellular network. These detectors receive the transmitted signal and transmit, to a central station, data indicating the signal strength of the received signal and the identity of the base stations receiving the signal. This data is processed to determine the distance between the vehicle and each of the base stations and, through trilateralization, the vehicle's position. However, these systems have drawbacks that include high expense in that special purpose electronics are required. Furthermore, the systems are generally only effective in line-of-sight conditions, such as rural settings. Radio wave surface reflections, refractions and ground clutter cause significant distortion, in determining the location of a signal source in most geographical areas that are more than sparsely populated. Moreover, these drawbacks are particularly exacerbated in dense urban canyon (city) areas, where errors and/or conflicts in location measurements can result in substantial inaccuracies.

Another example of a location system using time of arrival and triangulation for location are satellite-based systems, such as the military and commercial versions of the Global Positioning Satellite system (GPS). GPS can provide accurate position determination (i.e., about 100 meters error for the commercial version of GPS) from a time-based signal received simultaneously from at least three satellites. A ground-based GPS receiver at or near the object to be located determines the difference between the time at which each satellite transmits a time signal and the time at which the signal is received and, based on the time differentials, determines the object's location. However, the GPS is impractical in many applications. The signal power levels from the satellites are low and the GPS receiver requires a clear, line-of-sight path to at least three satellites above a horizon of about 60 degrees for effective operation. Accordingly, inclement weather conditions, such as clouds, terrain features, such as hills and trees, and buildings restrict the ability of the GPS receiver to determine its position. Furthermore, the initial GPS signal detection process for a GPS receiver is relatively long (i.e., several minutes) for determining the receiver's position. Such delays are unacceptable in many applications such as, for example, emergency response and vehicle tracking.

Differential GPS, or DGPS systems offer correction schemes to account for time synchronization drift. Such correction schemes include the transmission of correction signals over a two-way radio link or broadcast via FM radio station subcarriers. These systems have been found to be awkward and have met with limited success.

Additionally, GPS-based location systems have been attempted in which the received GPS signals are transmitted to a central data center for performing location calculations. Such systems have also met with limited success due, for example, to the limited reception of the satellite signals and the added expense and complexity of the electronics required for an inexpensive location mobile station or handset for detecting and receiving the GPS signals from the satellites.

The behavior of a mobile radio signal in the general environment is unique and complicated. Efforts to perform correlation between radio signals and distance between a base station and a mobile station are similarly complex. Repeated attempts to solve this problem in the past have been met with only marginal success. Factors include terrain undulations, fixed and variable clutter, atmospheric conditions, internal radio characteristics of cellular and PCS systems, such as frequencies, antenna configurations, modulation schemes, diversity methods, and the physical geometry of direct, refracted and reflected waves between the base stations and the mobile. Noise, such as man-made externally sources (e.g., auto ignitions) and radio system co-channel and adjacent channel interference also affect radio reception and related performance measurements, such as the analog carrier-to-interference ratio (C/I), or digital energy-per-bit/Noise density ratio ($E_{b/N_0}$) and are particular to various points in time and space domains.

Before discussing real world correlation between signals and distance, it is useful to review the theoretical premise, that of radio energy path loss across a pure isotropic vacuum propagation channel, and its dependencies within and among various communications channel types.

Over the last forty years various mathematical expressions have been developed to assist the radio mobile cell designer in establishing the proper balance between base station capital investment and the quality of the radio link, typically using radio energy field-strength, usually measured in microvolts/meter, or decibels.

One consequence from a location perspective is that the effective range of values for higher exponents is an increased at higher frequencies, thus providing improved granularity of ranging correlation.

Actual data collected in real-world environments uncovered huge variations with respect to the free space path loss equation, giving rise to the creation of many empirical formulas for radio signal coverage prediction. Clutter, either fixed or stationary in geometric relation to the propagation of the radio signals, causes a shadow effect of blocking that perturbs the free space loss effect. Perhaps the best known model set that characterizes the average path loss is Hata's, "Empirical Formula for Propagation Loss in Land Mobile Radio", M. Hata, *IEEE Transactions* VT-29, pp. 317-325, August 1980, three pathloss models, based on Okumura's measurements in and around Tokyo, "Field Strength and its Variability in VHF and UHF Land Mobile Service", Y. Okumura, et al, *Review of the Electrical Communications laboratory*, Vol 16, pp 825-873, Sept. - Oct. 1968.

Although the Hata model was found to be useful for generalized RF wave prediction in frequencies under 1 GHz in certain suburban and rural settings, as either the frequency and/or clutter increased, predictability decreased. In current practice, however, field technicians often have to make a guess for dense urban an suburban areas (applying whatever model seems best), then installing a base stations and begin taking manual measurements.

In 1991, U.S. Patent 5,055,851 to Sheffer taught that if three or more relationships have been established in a triangular space of three or more base stations (BSs) with a location database constructed having data related to possible mobile station (MS) locations, then arculation calculations may be performed, which use three distinct $P_{or}$ measurements to determine an X,Y, two dimensional location, which can then be projected onto an area map. The triangulation calculation is based on the fact that the approximate distance of the mobile station (MS) from any base station (BS) cell can be calculated based on the received signal strength. Sheffer acknowledges that terrain variations affect accuracy, although as noted above, Sheffer's disclosure does not account for a sufficient number of variables, such as fixed and variable location shadow fading, which are typical in dense urban areas with moving traffic.

Most field research before about 1988 has focused on characterizing (with the objective of RF coverage prediction) the RF propagation channel (i.e., electromagnetic radio waves) using a single-ray model, although standard fit errors in regressions proved dismal (e.g., 40-80 dB). Later, multi-ray models were proposed, and much later, certain behaviors were studied with radio and digital channels. In 1981, Vogler proposed that radio waves at higher frequencies could be modeled using optics principles. In 1988 Walfisch and Bertoni applied optical methods to develop a two-ray model, which when compared to certain highly specific, controlled field data, provided extremely good regression fit standard errors of within 1.2 dB.

In the Bertoni two ray model it was assumed that most cities would consist of a core of high-rise buildings surrounded by a much larger area having buildings of uniform height spread over regions comprising many square blocks, with street grids organizing buildings into rows that are nearly parallel. Rays penetrating buildings then emanating outside a building were neglected.

After a lengthy analysis it was concluded that path loss was a function of three factors: 1.) the path loss between antennas in free space; 2.) the reduction of rooftop wave fields due to settling; and 3.) the effect of diffraction of the rooftop fields down to ground level.

However, a substantial difficulty with the two-ray model in practice is that it requires a substantial amount of data regarding building dimensions, geometry, street widths, antenna gain characteristics for every possible ray path, etc. Additionally, it requires an inordinate amount of computational resources and such a model is not easily updated or maintained.

Unfortunately, in practice clutter geometry and building heights are random. Moreover, data of sufficient detail is extremely difficult to acquire, and regression standard fit errors are poor; i.e., in the general case, these errors were found to be 40-60 dB. Thus the two-ray model approach, although sometimes providing an improvement over single ray techniques, still did not predict RF signal characteristics in the general case to level of accuracy desired ( < 10dB).

Work by Greenstein has since developed from the perspective of measurement-based regression models, as opposed to the previous approach of predicting-first, then performing measurement comparisons. Apparently yielding to the fact that low-power, low antenna (e.g., 12-25 feet above ground) height PCS microcell coverage was insufficient in urban buildings, Greenstein, et al, authored "Performance Evaluations for Urban Line-of-sight Microcells Using a Multi-ray Propagation Model", in IEEE Globecom Proceedings, 12/91. This paper proposed the idea of formulating regressions based on field measurements using small PCS microcells in a lineal microcell geometry (i.e., geometries in which there is always a line-of-sight path between a subscriber's mobile and its current microsite). Additionally, Greenstein studied the communication channels variable Bit-Error-Rate (BER) in a spatial domain, which was a departure from previous research that limited field measurements to the RF propagation channel signal strength alone. However, Greenstein based his finding on two suspicious assumptions: 1) he assumed that distance correlation estimates were identical for uplink and downlink transmission paths; and 2) modulation techniques would be transparent in terms of improved distance correlation conclusions. Although some data held very correlation, other data and environments produced poor results. Accordingly, his results appear unreliable for use in general location context.

In 1993 Greenstein, et al, authored "A Measurement-Based Model for Predicting Coverage Areas of Urban Microcells", in the IEEE Journal On Selected Areas in Communications, Vol. 11, No. 7, 9/93. Greenstein reported a generic measurement-based model of RF attenuation in terms of constant-value contours surrounding a given low-power, low antenna microcell environment in a dense, rectilinear neighborhood, such as New York City. However, these contours were for the cellular frequency band. In this case, LOS and non-LOS clutter were considered for a given microcell site. A result of this analysis was that RF propagation losses (or attenuation), when cell antenna heights were relatively low, provided attenuation contours resembling a spline plane curve depicted as an asteroid, aligned with major street grid patterns. Further, Greenstein found that convex diamond-shaped RF propagation loss contours were a common occurrence in field measurements in a rectilinear urban area. The special plane curve asteroid is represented by the formula:

$x^{2/3} + y^{2/3} = r^{2/3}$. However, these results alone have not been sufficiently robust and general to accurately locate an mobile station, due to the variable nature of urban clutter spatial arrangements.

At Telesis Technology in 1994 Howard Xia, et al, authored "Microcellular Propagation Characteristics for Personal Communications in Urban and Suburban Environments", in IEEE Transactions of Vehicular Technology, Vol. 43, No. 3, 8/94, which performed measurements specifically in the PCS 1.8 to 1.9 GHz frequency band. Xia found corresponding but more variable outcome results in San Francisco, Oakland (urban) and the Sunset and Mission Districts (suburban).

The physical radio propagation channel perturbs signal strength, frequency (causing rate changes, phase delay, signal to noise ratios (e.g., C/I for the analog case, or $E_{b/No}$, RF energy per bit, over average noise density ratio for the digital case) and Doppler-shift. Signal strength is usually characterized by:

- Free Space Path Loss ($L_p$)
- Slow fading loss or margin ($L_{slow}$)
- Fast fading loss or margin ($L_{fast}$)

The cell designer increases the transmitted power $P_{TX}$ by the shadow fading margin $L_{slow}$ which is usually chosen to be within the 1-2 percentile of the slow fading probability density function (PDF) to minimize the probability of unsatisfactorily low received power level $P_{RX}$ at the receiver. The $P_{RX}$ level must have enough signal to noise energy level (e.g., 10 dB) to overcome the receiver's internal noise level (e.g., -118dBm in the case of cellular 0.9 GHz), for a minimum voice quality standard. Thus in this example $P_{RX}$ must never be below -108 dBm, in order to maintain the quality standard.

Additionally the short term fast signal fading due to multipath propagation is taken into account by deploying fast fading margin $L_{fast}$, which is typically also chosen to be a few percentiles of the fast fading distribution. The 1 to 2 percentiles compliment other network blockage guidelines. For example the cell base station traffic loading capacity and network transport facilities are usually designed for a 1-2 percentile blockage factor as well. However, in the worst-case scenario both fading margins are simultaneously exceeded, thus causing a fading margin overload.

In Roy Steele's, text, *Mobile Radio Communications*, IEEE Press, 1992, estimates for a GSM system operating in the 1.8 GHz band with a transmitter antenna height of 6.4m and a mobile station receiver antenna height of 2m, and assumptions regarding total path loss, transmitter power would be calculated as follows:

**Table I: GSM Power Budget Example**

| Parameter | dBm value | Will require |
|---|---|---|
| $L_{slow}$ | 14 | |
| $L_{fast}$ | 7 | |
| $Ll_{path}$ | 110 | |
| Min. RX pwr required | -104 | |
| | | TXpwr = 27 dBm |

Steele's sample size in a specific urban London area of 80,000 LOS measurements and data reduction found a slow fading variance of

$$\sigma = 7\mathrm{dB},$$

assuming log-normal slow fading PDF and allowing for a 1.4% slow fading margin overload, thus

$$_{\mathrm{slow}} = 2\sigma = 14\mathrm{dB}.$$

The fast fading margin was determined to be:

$$L_{\mathrm{fast}} = 7\mathrm{dB}$$

In contrast, Xia's measurements in urban and suburban California at 1.8 GHz uncovered flat-land shadow fades on the order of 25-30 dB when the mobile station (MS) receiver was traveling from LOS to non-LOS geometries. In hilly terrain fades of +5 to -50 dB were experienced. Thus it is evident that attempts to correlate signal strength with mobile station ranging distance suggest that error ranges could not be expected to improve below 14 dB, with a high side of 25 to 50 dB. Based on 20 to 40 dB per decade, Corresponding error ranges for the distance variable would then be on the order of 900 feet to several thousand feet, depending upon the particular environmental topology and the transmitter and receiver geometries.

Although the acceptance of fuzzy logic has been generally more rapid in non-American countries, the principles of fuzzy logic can be applied in wireless location. Lotfi A. Zadeh's article, "Fuzzy Sets" published in 1965 in *Information and Control*, vol. 8, Pg 338-353, herein incorporated by reference, established the basic principles of fuzzy logic, among which a key thorem, the FAT theorem, suggests that a fuzzy system with a finite set of rules can uniformly approximate any continuous (or Borel-measureable) system. The system has a graph or curve in the space of all combinations of system inputs and outputs. Each fuzzy rule defines a patch in this space. The more uncertain the rule, the wider the patch. A finite number of small patches can always cover the curve. The fuzzy system averages patches that overlap. The Fat theorem was proven by Bart Kosko, in a paper entitled, "Fuzzy Systems as Universal Approximators", in *Proceedings of the First IEEE Conference on Fuzzy Systems*, Pages 1153-1162, in San Diego, on March, 1992, herein incorporated by reference.

Fuzzy relations map elements of one universe, say "X", to those of another universe, say "Y", through the Cartesian product of the two universes. However, the "strength" of the relation between ordered pairs of the two universes is not measured with the characteristic function (in which an element is either definitely reltated to another elemetn as indicated by a strength value of "1", or is definitely not related to another element as indicated by a strength value of "0", but rather with a membership function expressing various "degrees" of strength of the relation on the unit intergval [0,1]. Hence, a fuzzy relation **R** is a mapping from the Cartesian space **X** x **Y** to the interval [0,1], where the strength of the mapping is expressed by the membership function of the relation for ordered pairs from the two universes or $\mu_R(x,y)$.

Just as for crisp relations, the properties of commutativity, associativity, distributivity, involution and idempotency all hold for fuzzy relations. Moreover, DeMorgan's laws hold for fuzzy relations just as they do for crisp (classical) relations, and the null relations **O**, and the complete relation, **E**, are analogous to the null set and the whole set in set-theretic from, respectively. The properties that do not hold for fuzzy relations, as is the case for fuzzy sets in general, are the excluded middle laws. Since a fuzzy relation **R** is also a fuzzy set, there is overlap between a relation and its complement, hence.

$$\mathbf{R} \cup \mathbf{R}' \neq \mathbf{E}$$

$$\mathbf{R} \cap \mathbf{R}' \neq \mathbf{O}$$

As seen in the foregoing expression, the excluded middle laws for relation do not result in the null relation, O, or the complete relation, E. Because fuzzy relations in general are fuzzy sets, the Cartesian product can be defined as a relations between two or more fuzzy sets. Let A be a fuzzy set on universe X and B be a fuzzy set on universe Y; then the Cartesian product between fuzzy sets A and B will result in a fuzzy relation R, which is contained within the full Cartesian product space, or

$$\mathbf{A} \times \mathbf{B} = \mathbf{R} \subset \mathbf{X} \times \mathbf{Y}$$

where the fuzzy relation R has membership function:

$$\mu_R(x,y) = \mu_{A \times B}(x,y) = \min(\mu_A(x), \mu_B(y))$$

Fuzzy composition can be defined just as it is for crisp (binary) relations. If **R** is a fuzzy relation on the Cartesian space **X** x **Y**, and **S** is a fuzzy relation on the Cartesian space **Y** x **Z**, and **T** is a fuzzy relation on the Cartesian space **X** x **Z**; then fuzzy max-min composition is defined in terms of the set-theoretic notation and membership function-theoretic notation in the following manner:

$$\mu_T(x,y) = \vee (\mu_R(x,y) \wedge \mu_S(x,y)) = \max \{ \min [\mu_R(x,y), \mu_S(y,z)] \}$$

The *fuzzy extension principle* allows for transforms or mappings of fuzzy concepts in the form y = f(x). This principle, combined with a *compositional rule of inference*, allows for a crisp input to be mapped through a fuzzy transform using membership functions into a crisp output. Additionally , in mapping a cariable x into a variale y, both x and y can be vector quantities.

## SUMMARY OF THE INVENTION

### OBJECTS OF THE INVENTION

It is an objective of the present invention to provide a system and method for determining wireless location using one or more commercial mobile radio telecommunication systems for accurately locating people and/or objects in a cost effective manner. Related objectives for the present invention include providing a system and method that:

(1) can be readily incorporated into existing commercial wireless telephony systems with few, if any, modifications of a typical telephony wireless infrastructure;

(2) can use the native electronics of typical commercially available telephony wireless mobile stations (e.g., handsets) as location devices;

(3) can be used for locating people and/or objects residing indoors.

Yet another objective is to provide a low cost location system and method, adaptable to wireless telephony systems, for using simultaneously a plurality of base stations owned and/or operated by competing commercial mobile radio service providers within a common radio coverage area, in order to achieve FCC phase 2 accuracy requirements, and for synergistically increasing mobile station location accuracy and consistency.

Yet another objective is to provide a low cost location system and method, adaptable to wireless telephony systems, for using a plurality of location techniques In particular, at least some of the following mobile station location techniques can be utilized by various embodiments of the present invention:

- time-of-arrival wireless signal processing techniques;
- time-difference-of-arrival wireless signal processing techniques;
- wireless signal processing techniques.

Yet another objective is to provide a system and method for flexible delivery of location information to Public Safety Answering Points, end users, centralized dispatchers, as well as to agents (either human or mechanized) associated with trigger-based inventory and tracking systems. Flexible delivery used here indicates providing location via various two dimensional closed-form shapes, such as polygons, ellipses, etc., which bound the location probabilities. In cases where height location information is known, the bounding shape may be three-dimensional.

Yet another objective is to provide a system and method for a variety of new location-based services for public and private group safety, including family support functions.

Yet another objective is to provide a system and method for National Scale Wireless Location capability. Although the primary focus of this patent is to provide wireless location with accuracy to meet the FCC phase two requirements, a system and method is provided that also utilizes roaming signaling to determine in which city is a particular wireless mobile station located.

Yet another objective is to provide and system and method for Parametric-driven, intelligent agent-based location services. Parameters may include time, location, and user-specific and/or group specific criteria.

Yet another objective is to provide a system and method for determining and/or enhancing wireless location using one or more of the following: (a.) CDMA-based Distributed Antenna technology; (b.) Home Base Stations and AIN technology.

Yet another objective is to provide notification messages and/or voice-synthesized call or text paging function to a plurality of other mobile station users when a mobile station user travel into, or away from, one or more zones or are within short distances of shopping malls, stores, merchandising dealers etc.

Yet another objective is to provide notification messages and/or voice-synthesized call or text paging functions to a plurality of other mobile station users when a mobile station dials a redefined telephone number, such as 911, or a type of "mild emergency cry for help' number.

Yet another objective is to provide notification messages and/or voice-synthesized call or text paging function to a plurality of other mobile station users when a mobile station user dials a predefined telephone number, such as 311, or a type of mild emergency cry for help number, wherein the plurality of other mobile station users are within a particular distance, or a minimum distance to the mobile station user who dialed the predefined number.

Yet another objective is to provide notification messages and/or voice-synthesized call or text paging function to a plurality of other mobile station users when a mobile station user dials a predefined telephone number, such as 311, or a type of mild emergency cry for help number, wherein the plurality of other mobile station users are within a particular distance, or a minimum distance to the mobile station user who dialed the predefined number, and wherein the other mobile station users are provided individualized directional or navigation information from their current locations, to reach to the mobile station user who dialed the predefined number.

Yet another objective is to provide automatic home office, vehicle and boat security functions, which are activated and deactivated based on a mobile station user's location to or away from a location associated with the security functions.

Yet another objective is to provide notifications (e.g., via fax, page, e-mail, text paging or voice synthesized call message), or to setup a group conference call capability to a plurality of predefined individuals, based on a mobile station user's call to 911, or based on a mobile station user's traveling into or away from a location zone or area, or based upon a sensor input signal to the user's mobile station, such as a sudden change in G forces, such as falling down, having the car hit another object suddenly, air bag deployment, etc.

Yet another objective is to provide location information to a 'searcher' mobile station user who then further refines or narrows the scope of the location/search for a 'target' mobile station, or the mobile station to be located, using a small microwave dish, in communication with, or to supplement/replace the searcher mobile station antenna, whose physical orientation is used to further determine the target mobile station location, relative to the searcher's mobile station position/orientation.

Yet another objective is to provide a means to allow more flexible storage, inventory and enhanced user accessibility of rental vehicles, by combining location technology of rental car driver carrying his/her own mobile station, along with a mobile station which remains always active and fixed to a rental car. By maintaining accurate location records of rental car locations and automatic, remote-control of rental cars (or smart cars) which use the mobile station to telemeter control data to and from the car, whose doors, doorlocks, and general accessibility are controlled by a centralized computer system, rental cars can be dropped off at convenient shopping center malls, airport parking lots, hotels and at other convenient locations.

Yet another objective is to provide location estimates to users carrying mobile stations, via voice synthesis, data circuit messaging or text paging.

Yet another objective is to provide a mechanism whereby mobile station users may access and control their subscriber profile for location purposes. The location subscriber profile is a persistent data store which contains logic regarding under what criteria will that mobile station user allow his/her location to be made known, and to whom. The mobile station user may access the location profile via several methods, including Internet means, and mobile station handset keypad entry and voice recognition circuits.

Yet another objective is to utilize signaling detection characteristics of other CDMA base stations and systems in a given area, owned and operated by a plurality another commercial mobile radio service provider (CMRS provider). By including other CMRS providers' infrastructure in the location estimation analysis process, improvements in location accuracy can be realized.

## DEFINITIONS

The following definitions are provided for convenience. In general, the definitions here are also defined elsewhere in this document as well.

(1) The term wireless herein is, in general, an abbreviation for digital wireless, and in particular, wireless refers to digital radio signaling using one of standard digital protocols such as CDMA, TDMA and GSM, as one skilled in the art will understand.

(2) As used herein, the term mobile station (equivalently, MS) refers to a wireless device that is at least a transmitting device, and in most cases is also a wireless receiving device, such as a portable radio telephony handset. Note that in some contexts herein instead or in addition to mobile station, the following terms are also used: personal station (PS), and location unit (LU). In general, these terms may be considered synonymous. However, the later two terms may be used when referring to reduced functionality communication devices in comparison to a typical digital wireless mobile telephone.

(3) The term, infrastructure, denotes the network of telephony communication services, and more particularly, that portion of such a network that receives and processes wireless communications with wireless mobile stations. In particular, this infrastructure includes telephony wireless base stations (BS) such as those for radio mobile communication systems based on CDMA, TDMA, and GSM wherein the base stations provide a network of cooperative communication channels with an air interface with the mobile station, and a conventional telecommunications interface with a Mobile Switch Center (MSC). Thus, an MS user within an area serviced by the base stations may be provided with wireless communication throughout the area by user transparent communication transfers (i.e., hand-offs) between the user's mobile station and these base stations in order to maintain effective

telephony service. The mobile switch center provides communications and control connectivity among base stations and the public telephone network.

(4) An example of a Parametric-driven intelligent agent-based location service follows: An intelligent agent software process monitors sets of Parametric conditions and location scenarios. When appropriate conditions and location criteria are satisfied, then a set of notifications or other actions are triggered to occur. A specific example follows: given that a certain child carrying a mobile station should be in a certain school between 8:00 A.M. and 3:00 P.M. on regular school days, then a wireless location request is invoked periodically, within the school day time frame. If a location request determines that the child's mobile station is located substantially outside of the general school area, then a parent/guardian is notified of that fact, and of the child's location via any of several methods, such as: (a.) a voice-synthesized telephone message, (b.) various extranet/internet means, such as electronic mail, netcasting, such as the product Castanet, by Marimba Software, Inc., (c.) fax to a pre-determined telephone number, or (d.) alpha-numeric text paging.

(5) Commercial mobile radio service (CMRS) service provider is the referenced name of the company that owns and/or operates a publicly accessible wireless system in the cellular or PCS spectrum radio bands.

## SUMMARY DISCUSSION

The location system of the present invention accomplishes the above and other objectives by the following steps:

(1.) receiving signal data measurements corresponding to wireless communications between an mobile station to be located (herein also denoted the target mobile station) and a wireless telephony infrastructure, wherein the mobile station, BS and/or mobile switch center may be enhanced in certain novel and cost effective ways so as to provide an extended number of values characterizing the wireless signal communications between the target mobile station and the base station infrastructure, such infrastructure including multiple, distinct CMRS where base stations share a common coverage area;

(2.) organizing and processing the signal data measurements received from a given target mobile station and surrounding base stations so that composite wireless signal characteristic values may be obtained from which target mobile station location estimates may be derived. In particular, the signal data measurements are ensembles of samples from the wireless signals received from the target mobile station by the base station infrastructure, and from associated base stations wherein these samples are subsequently filtered using analog and digital spectral filtering. (3.) providing the resultant location estimation characteristic values to a mobile station location estimate module, wherein each such model subsequently determines the estimate of the location of the target mobile station based on, for example, the signal processing techniques 1. through 2. above.

Accordingly, steps (1.) and (2.) above are performed by a subsystem of the invention denoted the Signal Processing and Filtering Subsystem (or simply the Signal Processing Subsystem). In particular, this subsystem receives samples of wireless signal characteristic measurements such as a plurality of relative signal strengths and corresponding signal time delay value pairs, wherein such samples are used by this subsystem to produce the component with the least amount of multipath, as evidenced in the sample by the short time delay value, wherein each such value pair is associated with wireless signal transmissions between the target mobile station and a particular base station of a predetermined wireless base station infrastructure. Extremely transient signal anomalies such as signal reflection from tree leaves or the passing of a truck are likely to be filtered out by the Signal Processing Subsystem. For example, such an ensemble of data value pairs can be subjected to input cropping and various median filters employing filtering techniques such as convolution, median digital, Fast Fourier transform, Radon transform, Gabar transform, nearest neighbor, histogram equalization, input and output cropping, Sobel, Wiener, and the like.

It is a further aspect of the present invention that the wireless personal communication system (PCS) infrastructures currently being developed by telecommunication providers offer an appropriate localized infrastructure base upon which to build various personal location systems employing the present invention and/or utilizing the techniques disclosed herein. In particular, the present invention is especially suitable for the location of people and/or objects using code division multiple access (CDMA) wireless infrastructures, although other wireless infrastructures, such as, time division multiple access (TDMA) infrastructures and GSM are also contemplated. Note that CDMA personal communications systems are described in the Telephone Industries Association standard IS-95, for frequencies below 1 GHz, and in the Wideband Spread - Spectrum Digital Cellular System Dual-Mode Mobile Station-Base Station Compatibility Standard, for frequencies in the 1.8-1.9 GHz frequency bands, both of which are incorporated herein by reference. Furthermore, CDMA general principles have also been described, for example, in U. S. Patent 5,109,390, to Gilhausen, et al, and CDMA Network Engineering Handbook by Qualcomm, Inc., each of which is also incorporated herein by reference.

In another aspect of the present invention, in environments where a home base station capability exists, then wireless location can be provided under certain circumstances, wherein when a mobile station user is within a predetermined range of, for example, 1000 feet of his/her premises, the user's mobile station is detected through mobile station receiving electronics provided in, for example, cordless telephone units as being at home. Thus, the local public telephone switching network may be provided with such information for registering that user is at home, and therefore the mobile station may be allowed to function as a cordless home telephone utilizing the local public telephone switching network instead of the base station infrastructure. According to this aspect of the present invention, the location center of the present invention receives notification from the local public switched telephone network that the mobile station is at or near home and utilizes this notification in outputting a location estimate for the mobile station.

In yet another aspect, the present invention includes a capability for locating a target mobile station within areas of poor reception for infrastructure base stations by utilizing distributed antennas. A distributed antenna system as used herein is a collection of antennas attached in series to a reduced function base station, wherein the antennas are distributed throughout an area for improving telephony coverage. Such distributed antenna systems are typically used in indoor environments (e.g., high rise buildings) or other areas wherein the signal to noise ratio is too high for adequate communication with standard infrastructure base stations. Also a distributed antenna system may be located such that its coverage pattern overlaps the area of coverage of another distributed antenna system. In such cases each of the overlapping distributed antenna systems includes purposeful delay elements to provide different signal delays for each of the overlapping antenna systems and thereby provide multipath signals with sufficient delay spread for signal discrimination, as one skilled in the art will understand. Accordingly, the present invention receives and utilizes location information communicated from distributed antenna systems for locating a target mobile station. That is, the present invention may receive information from the base station infrastructure indicating that a target mobile station is communicating with such a distributed antenna system and provide distributed antenna signal characteristic values related to the distributed antenna system. Accordingly, to process such target mobile station location signal data, the present invention includes a distributed antenna system for generating target mobile station location estimate derived from the location signal data obtained from the distributed antenna system.

The location system of the present invention offers many advantages over existing location systems. The system of the present invention, for example, is readily adaptable to existing wireless communication systems and can accurately locate people and/or objects in a cost-effective manner. In particular, the present invention requires few, if any, modifications to commercial wireless communication systems for implementation. Thus, existing personal communication system infrastructure base stations and other components of, for example, commercial CDMA infrastructures are readily adapted to the present invention. The present invention can be used to locate people and/or objects that are not in the line-of-sight of a wireless receiver or transmitter, can reduce the detrimental effects of multipath on the accuracy of the location estimate, can locate people and/or objects located indoors as well as outdoors, and uses a number of wireless stationary transceivers for location. The present invention employs a number of distinctly different location computational models for location which provides a greater degree of accuracy, robustness and versatility than is possible with existing systems. For instance, the location models provided include not only the radius-radius/TOA and TDOA techniques but also adaptive neural net techniques. Further, the present invention is able to adapt to the topography of an area in which location service is desired. The present invention is also able to adapt to environmental changes substantially as frequently as desired. Thus, the present invention is able to take into account changes in the location topography over time without extensive manual data manipulation.

Moreover, there are numerous additional advantages of the system of the present invention when applied in CDMA communication systems. The location system of the present invention readily benefits from the distinct advantages of the CDMA spread spectrum scheme, namely the exploitation of radio frequency spectral efficiency and isolation by (a) monitoring voice activity, (b) management of two-way power control, (c) provision of advanced variable-rate modems and error correcting signal encoding, (d) inherent resistance to fading, (e) enhanced privacy, and (f) multiple "rake" digital data receivers and searcher receivers for correlation of signal multipaths.

Additionally, note that this architecture need not have all modules co-located. In particular, it is an additional aspect of the present invention that various modules can be remotely located from one another and communicate with one another via telecommunication transmissions such as telephony technologies and/or the Internet. Accordingly, the present invention is particularly adaptable to such distributed computing environments. For example, some number of the location center modules may reside in remote locations and communicate their generated hypotheses via the Internet.

In an alternative embodiment of the present invention, the processing following the generation of location estimates by the modules may be such that this processing can be provided on Internet user nodes and the modules may reside at Internet server sites. In this configuration, an Internet user may request hypotheses from such remote modules and perform the remaining processing at his/her node.

Of course, other software architectures may also to used in implementing the processing of the location center without departing from scope of the present invention. In particular, object-oriented architectures are also within the scope of the present invention. For example, the modules may be object methods on an mobile station location estimator object, wherein the estimator object receives substantially all target mobile station location signal data output by the signal filtering subsystem 20. Alternatively, software bus architectures are contemplated by the present invention, as one skilled in the art will understand, wherein the software architecture may be modular and facilitate parallel processing.

One embodiment of the present invention includes providing the location of a mobile station (MS) using the digital air interface voice channel and an automatic call distributor device. This embodiment provides location information to either the initiating caller who wishes to learn of his location, using the voice channel, and/or location information could be provided to another individual who has either a wireline or wireless telephone station.

Another embodiment of the present invention includes providing the location of a mobile station using the digital air interface voice channel and a hunt group provided from a central office or similar device. This embodiment provides location information to either the initiating caller who wishes to learn of his location, using the voice channel, and/or location information could be provided to another individual who has either a wireline or wireless telephone station.

Another embodiment of the present invention includes providing the location of a mobile station using the digital air interface text paging, or short message service channel and a hunt group provided from a central office or similar device. This embodiment provides location information to either the initiating caller who wishes to learn of his location, using the voice channel, and/or location information could be provided to another individual who has either a wireline or wireless telephone station.

Another embodiment of the present invention includes providing the location of a plurality of mobile stations using the public Internet or an intranet, with either having the ability to further use "push", or "netcasting" technology . This embodiment provides location information to either the initiating Internet/Intranet user who wishes to learn of one or more mobile station locations, using either the Internet or an intranet. Either the mobile station user to be located can initiate a request for the user to be located, or an Internet/intranet user may initiate the location request. Optionally the location information could be provided autonomously, or periodically, or in accordance with other logic criteria, to the recipient of the location information via the Internet or a intranet. As a further option, location information can be superimposed onto various maps (e.g., bit/raster, vector, digital photograph, etc.) for convenient display to the user.

Yet another embodiment of the present invention includes providing a multicast notification to a group of mobile station users, based on distress call from a particular mobile station, wherein the group of mobile station users are relatively nearby the distress caller. The multicast notification provides individual directions for each group mobile station user, to direct each user to the fastest route to reach the distressed caller.

Further features and advantages of the present invention are provided by the figures and detailed description accompanying this invention summary.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 illustrates an overall view of a wireless location system and method for using multiple commercial mobile radio service providers;

Fig. 2 shows is a high level wireless location architecture using the intelligent network, which illustrates aspects of the home base station and Internet connectivity for receiving location requests and for providing location estimates;

Fig. 3 illustrates how the signals from the base stations associated with various multiple commercial radio service providers can be shared with the wireless location system to provide an improved geometry and thus improved wireless location accuracy.

Fig. 4 shows how the mobile station database in the location system is updated via interfaces in communication with multiple commercial mobile radio service providers using customer care systems.

Fig. 5 shows a method of direct access to multiple CMRS base stations, from the location system perspective, thus avoiding the need to significantly modify network infrastructure systems.

Fig.6 illustrates physical components and the effects of predetermined signal delay, and total system delay in a distributed antenna environment for purposes of wireless location;

Fig. 7 shows the timing relationships among the signals within a distributed antenna system.

Fig. 8 shows a flowchart of the methods and procedures required to implement a DA database;

Fig. 9 illustrates an exemplary DA configuration with a direct antenna connection to the base stations;

Fig. 10 illustrates an alternative DA configuration using multipoint microwave;

Fig. 11 illustrates how multiple base stations could be used via a microwave circuit to provide PCS and location service to a multilevel building via virtual pilot channels;

Fig. 12 shows the DA delay spread ranges possible for a 500 microsecond guard zone;

Fig. 13 shows DA-cell layout a geometry and how location geometries can be constructed;

Fig.14 illustrates the realization of actual measurements and classification utilized within DA cell ranges to determine a percent range within each cell.

Fig. 15 shows the standard components of a CDMA MS.

Fig. 16 shows one embodiment for MS modification that facilities enhanced RF measurement telemetry.

Fig. 17 shows how the LC is used in a Home Base Station architecture.

Fig. 18 illustrates a typical case where signals from three base stations can be detected.

Fig. 19 illustrates a typical case where signals from four base stations (including remaining set information) can be detected.

Fig. 20 shows a MS detection scheme with a two base station geometry.

Fig. 21 illustrates a typical amorphous location area with only the signal detection of a single base station sector, by a MS.

Fig. 22 shows a series of typical reverse path CDMA RF measurements in a dense urban area.

Fig. 23 shows a series of typical reverse path CDMA RF measurements in a rural setting.

Fig. 24 shows a typical Location Center connection to a CTIA Model.

Fig. 25 shows a typical national Location Center and relevant network connections.

Fig. 26 illustrates a typical three dimensional delay spread profile.

Fig. 27 shows the magnifying effects of convoluting similar-property forward and reverse path three-dimensional images.

Fig. 28 illustrates an image and relief representation of a CDMA Delay Spread Profile.

Fig. 29 illustrates the main components of the Signal Processing Subsystem 20.

Fig. 30 illustrates an image based on an RF signal measurement sample set, before image histogram equalization filtering is applied.

Fig. 31 illustrates an image based on an RF signal measurement sample set, after image histogram equalization input cropping filtering is applied.

Fig. 32 illustrates an image sample grid before image filtering.

Fig. 33 shows a CDMA profile image after input cropping is used at a level of 50 percent.

Fig. 34 illustrates the results of combining input cropping at 40 percent, then performing four by four median filtering on the resultant.

Fig. 35 shows the results of combining input cropping at 50 percent with four by four median filtering.

Fig. 36 illustrates how location estimates can be provided using voice channel connections via an ACD and Internet technology.

Fig. 37 shows wireless Location of a MS using the Voice Channel from a Hunt Group.

Fig. 38 illustrates how location information can be provided via Text paging or short message service messaging.

Fig. 39 shows how location information of an MS can be provided via Internet via "Push" technology.

Fig. 40 illustrates how location directions can be provided to nearest members, regarding directions for each individual member to reach a distressed MS caller.

Fig.41 illustrates how traveling instructions from two different points can be provided to an initiator.

Fig.42 illustrates how wireless location services can be used to facilitate automotive rental car tracking and control.

Fig. 43 indicates the addition of a fuzzy logic module which discretizes the wireless location estimate output from the TOA/TDOA locaton estimator module.

## DETAILED DESCRIPTION

Various digital wireless communication standards have been introduced such as code division multiple access (CDMA) and Time Division Multiple Access (TDMA) (e.g., Global Systems Mobile (GSM). These standards provide numerous enhancements for advancing the quality and communication capacity for wireless applications. Referring to CDMA, this standard is described in the Telephone Industries Association standard IS-95, for frequencies below 1 GHz, and in J-STD-008, the Wideband Spread-Spectrum Digital Cellular System Dual-Mode Mobile Station-Base station Compatibility Standard, for frequencies in the 1.8 - 1.9 GHz frequency bands.

Additionally, CDMA general principles have been described, for example, in U.S. Patent 5,109,390, Diversity Receiver in a CDMA Cellular Telephone System, by Gilhousen. There are numerous advantages of such digital wireless technologies such as CDMA radio technology. For example, the CDMA spread spectrum scheme exploits radio frequency spectral efficiency and isolation by monitoring voice activity, managing two-way power control, provision of advanced variable-rate modems and error correcting signal design, and includes inherent resistance to fading, enhanced privacy, and provides for multiple "rake" digital data receivers and searcher receivers for correlation of multiple physical propagation paths, resembling maximum likelihood detection, as well as support for multiple base station communication with a mobile station, i.e., soft or softer hand-off capability. When coupled with a location center as described herein, substantial improvements in radio location can be achieved. For example, the CDMA spread spectrum scheme exploits radio frequency spectral efficiency and isolation by monitoring voice activity, managing two-way power control, provision of advanced variable-rate modems and error correcting signal design, and includes inherent resistance to fading, enhanced privacy, and provides for multiple "rake" digital data receivers and searcher receivers for correlation of multiple physical propagation paths, resembling maximum likelihood detection, as well as support for multiple base station communication with a mobile station, i.e., soft hand-off capability. Moreover, this same advanced radio communication infrastructure can also be used for enhanced radio location. As a further example, the capabilities of IS-41 and AIN already provide a broad-granularity of wireless location, as is necessary to, for example, properly direct a terminating call to a mobile station. Such information, originally intended for call processing usage, can be re-used in conjunction with the location center described herein to provide wireless location in the large (i.e., to determine which country, state and city a particular mobile station is located) and wireless location in the small (i.e., which location, plus or minus a few hundred feet within one or more base stations a given mobile station is located).

Fig. 1 illustrates a wireless location network using two commercial mobile radio service provider networks for the present invention. Accordingly, this figure illustrates the interconnections between the components of a typical wireless network configuration and various components that are specific to the present invention. In particular, as one skilled in the art will understand, a typical wireless network includes: (a) a mobile switching center (MSC) 12a; (b) generally a service control point 4a, and base stations (not shown) which are in communication with a mobile switch center 12a. Within a typical metropolitan area it is also common for a second commercial mobile radio service (CMRS) provider to offer wireless service within essentially similar coverage areas, such systems typically including an mobile switch center 12b, service control point 4b, and associated base stations (not shown). Added to this wireless network, the present invention provides the following additional components:

(1) a location system or center 42 which is required for determining a location of a target mobile station using signal characteristic values as measured by the target mobile station (not shown) and nearby base stations (not shown), further consisting of the following modules or subsystem components:

(1.1) an application programming interface 14, for physically interfacing with and controlling the messaging to and from each CMRS mobile switch center 12a, 12b, service control points 4a and 4b, receiving location requests from either the mobile switch center 12a, or 12b, or the Internet 68, and providing connection to the signal processing subsystem 20;

(1.2) a signal processing subsystem 20, which is in communication with the application programming interface (API) 14. The signal processor 20 receives, queues, filters and processes signal measurement messages into various formats suitable for the location estimate modules DA 10 and TOA/TDOA 8;

(1.3) a TOA/TDOA location estimate module 8, in communication with the signal processing subsystem 20. The TOA/TDOA module 8 provides a location estimate result, using a time of arrival or a time difference of arrival technique based on conditioned signals from the signal processing subsystem 20; in addition the TOA/TDOA module may also process signals from the distributed antenna module 10, in order to provide a location estimate within environments containing distributed antenna systems;

(1.4) a distributed antenna (DA) module 10, which receives signals related to distributed antennas, from the signal processor 20 in communication a location estimating capability for utilizing one or more distributed antenna systems 168 as shown in Fig. 2, wherein each such system 168 provides wireless location information for an MS 140 within the area in communication with one or more distributed antenna system 168.

(1.5) a home base station module (HBS) 6 in Fig. 1, which receives signals from the controller 14 and determines wireless location (i.e., providing a location estimate result) based on registration principles of the wireless user's mobile station when in communication with the user's home base station (not shown) in communications with a given service control point 4a or 4b, containing ahome base station application (not shown).

Since home base stations and distributed antenna systems can be located on potentially each floor of a multi-story building, in such cases where infrastructure is installed, the wireless location technology described herein can be used to perform location in terms of height as well as by Latitude and Longitude.

Referring to Fig. 2, additional detail is provided of typical base station coverage areas, sectorization, and high level components used in the present invention's scope, including the mobile switch center 112, a mobile station 140 in communication with a home base station 160, and communication between the location system 42 and the public Internet 468, via an Internet service provider interface 472. A novel aspect of this invention includes providing wireless location estimate information to various designated users via the public Internet. Although base stations may be placed in any configuration, a typical deployment configuration is approximately in a cellular honeycomb pattern, although many practical tradeoffs exist, such as site availability, versus the requirement for maximal terrain coverage area. To illustrate, such exemplary base stations (BSs) 122a through 122g are shown, each of which radiate referencing signals within their area of coverage to facilitate mobile station (MS) 140 radio frequency connectivity, and various timing and synchronization functions. A given base station may contain no sectors (not shown) , thus radiating and receiving signals in a 360 degree omnidirectional coverage area pattern, or the base station may contain "smart antennas" (not shown) which have specialized coverage area patterns.

Alternatively and generally most frequent are base stations having three sector coverage area patterns. Shown in Fig. 2, each sector for base station 122a through 122g contains three sectors, labeled a, b, and c, which represent antennas that radiate and receive signals in an approximate 120 degree arc, from an overhead view. As one skilled in the art will understand, actual base station coverage areas generally are designed to overlap to some extent, thus ensuring seamless coverage in a geographical area. Control electronics within each base station are used to communicate with a given mobile station 140. Further, during communication with the mobile station the exact base station identification and sector identification information are known and are provided to the location center 142.

The base stations located at their cell sites may be coupled by various transport facilities 176 such as leased lines, frame relay, T-Carrier links, optical fiber links or by microwave communication links.

When the mobile station is powered on and in the idle state, it constantly monitors the pilot signal transmissions from each of the base stations located at nearby cell sites. As illustrated in Fig. 3, base station/sector coverage areas may often overlap both in the context of a single CMRS base station network, and also in the context of multiple CMRS base station networks, thus enabling mobile stations to detect, and, in the case of certain technologies, communicate simultaneously along both the forward and reverse paths, with multiple base stations/sectors, either with a single CMRS network or, in the case of hand-offs and roaming, multiple CMRS network equipment. In Fig. 3 the constantly radiating pilot signals from base station sectors 122a, 122b and 122c are detectable by mobile station 140 at its location. The mobile station 140 scans each pilot channel, which corresponds to a given base station/sector ID, and determines which cell it is in by comparing signals strengths of pilot signals transmitted from these particular cell-sites.

The mobile station 140 then initiates a registration request with the mobile switch center 112, via the base station controller 174. The mobile switch center determines whether or not the mobile station 140 is allowed to proceed with the registration process (except in the case of a 911 call, wherein no registration process is required). At this point calls may be originated from the mobile station 140 or calls or short message service messages can be received from the mobile switch center 112.

As shown in Fig. 2, the mobile switch center 112 communicates as appropriate, with a class 4/5 wireline telephony circuit switch or other central offices, with telephone trunks in communication with the public switch telephone network (PSTN) 24. Such central offices connect to wireline stations, such as telephones, or any communication device compatible with the line, such as a personal or home base station. The PSTN may also provide connections to long distance networks and other networks.

The mobile switch center 112 may also utilize IS/41 data circuits or trunks 522, which in turn connects to a service control point 104, using, for example, signaling system #7 (SS7) signaling link protocols for intelligent call processing, as one skilled in the art will understand. In the case of wireless advanced intelligent network (AIN) services such trunks and protocols are used for call routing instructions of calls interacting with the mobile switch center 112 or any switch capable of providing service switching point functions, and the public switched telephone network (PSTN) 24, with possible termination back to the wireless network. In the case of an mobile station 140 in communication with a corresponding home or office base station (HBS) 160, the HBS 160 controls, processes and interfaces the mobile station 140 to the PSTN 24, in a manner similar to a cordless telephone system, except that added AIN logic within, for example, the service control point (SCP) 104 is used to determine if the mobile station 140 is being controlled by the HBS 160 or a wireless base station 122. Regarding non-HBS calls, the mobile switch center 112 may direct calls between mobile stations 140 via the appropriate cell site base stations 122 a through 122h since such mobile stations 140 do not typically communicate directly with one another in such wireless standards as CDMA, TDMA NAMPS, AMPS and GSM.

Referring again to Fig. 2, the Location system 42 interfaces with the mobile switch center 112 either via dedicated transport facilities 178, using for example, any number of LAN/WAN technologies, such as Ethernet, fast Ethernet, frame relay, virtual private networks, etc., or via the PSTN 24 (not shown). The location system 42 receives autonomous (e.g., unsolicited) autonomous or command/response messages regarding, for example: (a) the wireless network states, including for example, the fact that a base station has been taken in or out of service, (b) mobile station 140 and BS 122 radio frequency (RF) signal measurements, notifications from a SCP 104 indicating that an HBS 160 has detected and registered with the SCP 104 the mobile station 140 corresponding to the HBS 160, and (c) any distributed antenna systems 168. Conversely, the location system 42 provides data and control information to each of the above components in (a) - (c). Additionally, the Location system 42 may provide location information to an mobile station 140, via a BS 122, using, for example the short message service protocol, or any data communication protocol supported by the air interface baetween the base station and the mobile station. Interface 106 connecting the location system 42 with the service control point 104 may also be required in the event the home location register and/or the home base station AIN function is located in the SCP 104.

Assuming the wireless technology CDMA is used, each BS 122a, 122b, 122c, through 122g uses a time offset of the pilot PN sequence to identify a forward CDMA pilot channel. Furthermore, time offsets, in CDMA chip sizes, may be re-used within a PCS system, thus providing efficient use of pilot time offset chips, thus achieving spectrum efficiency.

The use of distributed antennas is another technique for improving or extending the RF coverage of a radio coverage area 120 of a wireless system. Such distributed antennas are typically used in buildings or other areas of dense clutter, such as numerous walls, partitions and/or similar structures causing substantial signal attenuation. As shown in Figs. 6, 9, 10, 11, and 13, distributed antennas 168 are typically connected together in a serial fashion for communicating with one or more infrastructure base stations 122. Distributed atennnas may be connected to the mobile switch center 112 via various air interfaces, as shown in Figs. 10 and 11, or alternatively distributed antennas may be connected to the MSC via a directed connection to a base station 122 as shown in Fig. 9, or via a private branch exchange (PBX) as shown in Fig. 13.

Referring to Fig. 11, distributed antennas 168 are useful particularly in wireless system configurations involving microcells, and potentially indoor environments, such as wireless systems in communication with private branch exchange systems (reference Fig. 13) in business offices, and in wireless local loop applications (not shown) as one skilled in the art will understand. Additionally, a distributed antenna embodiment can provide significant improvements in decreasing location error, as compared with an indoor mobile station 140 (reference Fig. 11) user with a wireless connection to an outdoor, infrastructure base station 122, as illustrated in Figs. 11, 12, 13 and 14.

## MOBILE STATION DESCRIPTION

As an example of a mobile station 140, such a mobile station will be described using CDMA technology. Fig. 15 illustrates a typical block diagram of the functional components of a CDMA mobile station (MS) 140, based on the patent, "Diversity Receiver in a CDMA Cellular Telephone System", patent number 5,109,390. The MS 140 contains an antenna 510 coupled through diplexer 512 to analog receiver 514 and transmit power amplifier 516. Antenna 510 and diplexer 512 permit simultaneous transmission and reception of signals through an antenna 510. Antenna 510 collects transmitted signals and provides them through diplexer 512 to analog receiver 514. Receiver 514 receives the RF frequency signals, typically either in the 800-900 MHZ or 1.8-1.9 GHz band, from diplexer 512, for amplification and frequency down conversion to an intermediate frequency (IF). Translation is accomplished through the use of a frequency synthesizer of standard design which permits the receiver 514 to be tuned to any of the frequencies within the designated receive frequency band. The IF signal is passed through a surface acoustic wave bandpass filter, typically of 1.25 MHZ bandwidth, to match the waveform of the signal transmitted by a base station 122. Receiver 514 also provides an analog to digital converter (not shown) for converting the IF signal to a digital signal. The digital signal is provided to each of four or more data receivers (520, 522, 524, and 526), one of which is a searcher receiver (526) with the remainder being data receivers, as one skilled in the art will understand.

Analog receiver 514 also performs a open-loop type of power control function for adjusting the transmit power of the mobile station 140 on the reverse link channel. Receiver 514 measures the forward link signal strength of the signals from base stations 122, then generates an analog power control signal to circuitry in the transmit power amplifier 516, which can effect a range up to about 80 dB. The power control for the transmit power amplifier 516 is also supplemented by a closed-loop power control or mobile attenuation code (MAC) control parameter sent to the mobile station 140 via the air (i.e., wireless) interface from a BS 122, with either the CMAC or VMAC command (as one knowledgeable in CDMA standards will understand). The MAC can take on one of eight values 0 through 7, which effect a closed loop to raise or lower the power correction. The transmit amplifier 516 may utilize one of three transmit power classes when transmitting within a transmitted power control group in the 800-900 MHZ cellular band: class I (1 to 8 dBW), class II (-3 to 4 dBW), or class III (-7 to 0 dBW), for a closed-loop range of about " 32 dB. In the PCS 1.8-1.9 GHz band five classes are defined: class I (-2 to 3 dBW), class II (-7 to 0 dBW), class III (-12 to -3 dBW), class IV (-17 to -6 dBW), class V (-22 to -9 dBW), for a closed-loop range of about " 40 dB. The mobile station 140 power class and transmit power level for a communicating mobile station 140 is known to the wireless infrastructure network, and may be utilized for location estimation, as is described hereinbelow.

The digitized IF signal may contain the signals from several telephone calls together with the pilot channels and multipath delayed signals from each of several pilot channels. Searcher receiver 526, under control of control processor 534, continuously scans the time domain around the nominal time delay offsets of pilot channels contained within the active, candidate, neighboring and remaining sets of pilot channels. The initial sets of pilot channels and a defined search window size for each set are provided by a control message from a BS 122 via the air interface to the mobile station 140. The searcher receiver 526 measures the strength of any reception of a desired waveform at times other than the nominal time and measures each pilot channel's arrival time relative to each pilot's PN sequence offset value. Receiver 526 also compares signal strength in the received signals. Receiver 526 provides a signal strength signal to control processor 534 indicative of the strongest signals and relative time relationships.

Control processor 534 provides signals to control digital data receivers 520, 522 and 524 such that each of these receivers processes a different one of the strongest signals. Note, as one skilled in the art will understand, the strongest signal, or finger, may not be the signal of shortest arrival time, but rather may be a reflected, and therefore delayed, signal (such reflected denoted collectively as "multipath"). Data receivers 520, 522 and 524 may track and process multipath signals from the same forward channel pilot channel offset or from a different forward channel pilot offset. In the case where a different pilot channel offset signal is of greater strength than the current cell site (or more specifically the current base station 122) pilot channel offset, then control processor 534 generates a control message for transmission on a reverse channel from the mobile station 140 to the current BS 122, requesting a transfer of the call, or a soft hand-off, to the now strongest cell site Base station 122. Note that each of the four receivers 520, 522, 524 and 526 can be directed independently from each other. The three data receivers 520, 522, and 524 are capable of tracking and demodulating multipath signals from of the forward CDMA pilot channel. Thus data receivers 520, 522 and 524 may provide reception of information via separate multipath signals from one BS 122 (e.g., in particular, an antenna face of a sectored antenna at the BS 122, or reception of signals from a number of sectors at the same BS 122, or reception of signals from multiple BSs 122 or their antenna faces of sectored antennas. Upon receiving a CDMA pilot measurement request order command, or whenever: (a) the mobile station 140 detects a pilot signal of sufficient strength, not associated with any of the assigned forward traffic channels currently assigned, or (b) the mobile station 140 is in preparation for a soft or hard hand-off, then the searcher receiver 526 responds by measuring and reporting the strengths of received pilots and the receiver's definition of the pilot arrival time of the earliest useable multipath component of the pilot, in units of PN chips (one chip = 0.813802 microseconds). The receiver 526 computes the strength of a pilot by adding the ratios of received pilot energy per chip $E_c$, to total received spectral density, $I_o$, of at most k useable multipath components, where k is the number of data receivers supported in the mobile station 140.

The outputs of data receivers 520, 522, and 526 are provided to diversity combiner and decoder circuitry 538 (i.e., simply diversity combiner). The diversity combiner 538 performs the function of adjusting the timing of a plurality of streams of received signals into alignment and adds them together. In performing this function, the diversity combiner 538 may utilize a maximal ratio diversity combiner technique. The resulting combined signal stream is then decoded using a forward stream error detection contained within the diversity combiner. The decoded result is then passed on to the user digital baseband circuitry 542.

The user digital baseband circuitry 542 typically includes a digital vocoder which decodes the signals from diversity combiner 538, and then outputs the results to a digital to analog (D/A) converter (not shown). The output of the D/A serves as an interface with telephony circuitry for providing mobile station 140 user analog output information signals to the user corresponding to the information provided from diversity combiner 538.

User analog voice signals typically provided through an mobile station 140 are provided as an input to baseband circuitry 542. Baseband 542 serves as an interface with a handset or any other type of peripheral device, to the user for audio communication. Baseband circuitry 542 includes an analog to digital (A/D) converter which converts user information signals from analog form into a digital form. This digital form is then input to a vocoder (not shown) for encoding, which includes a forward error correction function. The resulting encoded signals are then output to transmit modulator 546.

Transmit modulator 546 modulates the encoded signal on a PN carrier signal whose PN sequence is based on the assigned address function for a wireless call. The PN sequence is determined by the control processor 534 from call setup information that was previously transmitted by a cell site BS 122 and decoded by the receivers 520, 522, 524 as one skilled in the art will understand. The output of transmit modulator 546 is provided to transmit power control circuitry 550. Note that signal transmission power is controlled partially by an open-loop analog power control signal provided from receiver 514. In addition, control bits are also transmitted by the controlling BS 122 in the form of a supplemental closed-loop power adjustment command and are processed by data receivers 520, 522,. In response to this command, control processor 534 generates a digital power control signal that is provided to the transmit power amplifier 516. Transmit power control 550 also provides the digitized and encoded user information signals in an IF format to output to the transmit power amplifier 516. The transmit power amplifier 516 converts the IF format signals into an RF frequency by mixing this signal with a frequency synthesizer (not shown) output signal for providing a corresponding signal at the proper output transmission frequency signal. Subsequently, transmit power amplifier 516 amplifies the signal to the final power output level. The transmission signal is then output from the transmit power amplifier 516 to the diplexer 512. The diplexer 512 then couples the transmission signal to antenna 510 for air interface transmission to the infrastructure base stations 122.

Additionally, note that control processor 534 is also responsive to various control and information request messages from the controlling BS 122, including for example, sync channel messages, the system parameters messages, in-traffic system parameters messages, paging/alert messages, registration messages, status requests, power control parameters messages and hand-off direction messages, as one skilled in the art will understand.

Referring still to a CDMA mobile station 140, in one embodiment of the present invention, the above-described standard CDMA mobile station architecture in an mobile station 140 is sufficient. However, in a second embodiment, this architecture may be modified in minor, cost effective ways so that additional information may be transmitted from an mobile station 140 to the BS 122. The modifications for this second embodiment will now be described. The following modifications, either together or in any combination, provide improvements in location accuracy from the perspective of capturing RF measurement data: (1) increasing measurement quantity, (2) improving measurement transmission, (3) extending the pilot set and search, (4) extending the pilot signal reporting capabilities, 5) decreasing the Quantization size of the units used to report the pilot PN phase arrival time, 6) improving the accuracy of the mobile and base station time reference, and 7) increasing the number of data receivers and related circuitry, for correlation tracking of a larger plurality of pilot channels and each of their multipath signals.

Using the standard system parameters overhead message in the paging channel as one method of reporting to the base station the signal strengths and delays of detectable pilot channels, a mobile station has various timers indicating the upper bounds of time needed to respond to a request, and to bid for access to the forward channel (if not already using it's assigned traffic channel). These timers restrict the frequency of measurement reporting and thus limit the aggregate amount of measurement data which can be sent in a given time period.

For example, CDMA standard timer $T_{33_m}$ establishes the maximum time of a mobile station to enter the update overhead information substate of the system access state to respond to messages received while in the mobile station idle state, typically 0.3 seconds. Timer $T_{58m}$, the maximum time for the mobile station to respond to one service option request, is typically 0.2 seconds. Thus during a period of about five seconds, this measurement reporting method would provide for a maximum of about fifteen measurements.

However the same CDMA receiver design infrastructure, with slight circuitry modification can be used to support improved measurement transmission.

In order to collect a data ensemble of RF measurements that represents a statistically significant representation of data values in a geographical area of interest, it is the intention that the second (CDMA) mobile station 140 embodiment be capable of sending to the network base station infrastructure approximately 128 samples of each multipath peak signal strength and its relative delay, for each detectable pilot channel, in less than a preferred period of about five seconds. In order to transmit this amount of data, other means are needed to efficiently send the needed data to the network (i.e., from the mobile station to the base station, and then to forward data to the wireless switch, and then to forward data to the Location Center).

The CDMA air interface standard provides several means for transmitting data at higher rates. The Data Burst message can be used, or various blank-and-burst, dim-and-burst multiplex options can be used, and well as selecting various service options 2 through 9, through the setup of a normal voice or data telephone call. In one embodiment, , the user dials a speed number representing a data-type call to the Location Center 142, which initiates a command to the mobile station 140, responsive by the mobile station 140, which then provides the location center 142, via the base station 122, mobile switch center 112 with the needed measurement data.

Referring to Fig. 16, in one embodiment a software controllable data connection or path 49 is established between the control processor 46, and the user digital baseband 30 functional components in the mobile station, a much larger quantity of RF measurements, on the order of 128 data samples, can be transmitted as a data burst, multiplexed, or sent by other means such as a data circuit call, back to the network, and to the Location Center. Note that the existing connection between the control processor 534 and the transmit modulator 546 may also be used, as well via any other virtual path, such as software register-to-register move instructions, as long as sufficient signal measurement content and data samples can be sent to the wireless network and the location center 142 via the associated interfaces. Those skilled in the art will understand the wireless network consists of the base station, mobile switch center, and related infrastructure equipment, interfaces and facilities circuits to telemeter the measurement content and data samples to the location center 142. Additional design issues include, for example, the fact that existing memory in the mobile station must be allocated to the temporary storage of RF sample measurements, and new control means, such as selecting a future use control bit pattern in the CDMA air standard, are required to telemeter, preferably upon command, RF measurement sample data to the Location Center 142 in Fig. 1. In the case where a location request is received by the location engine 139 in the location center 142, the location engine 139 initiates a message to the mobile station 140 via a signal processing subsystem and the location center mobile switch center physical interface, the location applications programming interface 136 for the mobile switch center 112 and the wireless network infrastructure.

The addition of a controllable data connection or path 49 can be easily performed by CDMA application-specific integrated circuit (ASIC) manufacturers. In the case of one ASIC manufacturer known to the authors, the Qualcomm ASIC chip mobile station modem, model number MSM 2300, provides both the control processor function 534 and the user digital baseband 542 functions or the same chip, thus the external pinout physical configuration would not have to change to accommodate the wireless location software controllable data connection or path 49 modification.

If the mobile station 140 searcher receiver detects 4 pilots with 4 multipaths each, with each measurement consisting of a pilot index, finger identification, multipath signal strength, and multipath arrival time, then about 480 bytes are needed per measurement. Assuming the searcher receiver performs one measurement every 10 mS, about 1 second is needed to compile and buffer each sample of 128 measurements per sample, or about 48 kilobytes. Using a typical 9600 kbps CDMA data channel between the mobile station 140 and a BS 122, and assuming a 50 percent overhead, the mobile station can complete the collection and transmission of a location measurement sample in less than ten seconds, which is within a reasonable period for satisfying a location request.

The implementation of the data services required to telemeter the necessary signal measurements may be performed in any of several embodiments. In one embodiment the location signal measurements request-response application message set utilizes the air interface services provided by the spare bits and digital control words not currently in the air interface standards IS-95 and ANSI-J-STD-008. Such bits and control words can be reserved for the purpose of requesting and providing the required location signal measurements discussed herein. Using this embodiment the base station and mobile switch center must be modified to support the interworking function required between the location center and the mobile station. In a second embodiment the location signal measurements request-response application message set is implemented using service options 4 and 12, which provides asynchronous data transmission capability, as defined in *TR45 Data Standard, Async and Fax Section*, document number TIA/EIA/IS-DATA.4. Using this second embodiment, the mobile station control processor provides, or would interface with a function emulating mobile termination 0 or 2 services at the $R_m$ network reference point. The L-API then provides, or would interface with a function emulating the physical interface connecting a data circuit-terminating equipment (DCE) to the PSTN at the W network reference point, in communication with the PSTN, which is also in communication with reference point Ai, which is in communication with reference point $U_m$, which is in turn in communication with reference point $R_m$. An advantage of this embodiment is that no ASIC or circuit board modifications are needed in the mobile station.

The ANSI standards J-008 and IS-95 provide several means for the base station 122 to establish and to extend the search window size that the mobile station 140 should use in its scanning process, and to identify further pilots. For location purposes, either existing standard parameters can be extended, or a location message request from the Base station can inform the searcher receiver of the mobile station to extend its search range, as necessary, to capture all relevant base station pilots and their multipath fingers, in order to complete the location measurement sample.

The search performance criteria defined in ANSI IS-98, Recommended Minimum Performance Standards for Dual Mode, can be increased as appropriate to accommodate a larger set of potentially detectable base stations, including Location Base stations and Mobile Base stations. Additionally the search window table size for various search window values must be increased to accommodate new pilot channel pn-offsets associated with Location Base Stations and Mobile Base stations.

Existing standard parameters include, for example using the In-traffic System Parameters Message, the values SRCH_WIN_A (for active and candidate set), SRCH_WIN_N (for neighboring set), and SRCH_SIN_R (for remaining set) can be used to cause the searcher receiver to increase its search area to detect and thus measure as many pilots as can be detected in the area. Extending the range of T_ADD and T_DROP parameters can also be used to facilitate the mobile to retain data on additional pilots in the area. The extended neighbor list message is used to inform the mobile station of the necessary characteristics of neighboring pilot signals. For example if location base stations are used on a different frequency assignment, and/or utilize unique, non-public pilot PN sequence offset indices, for example, in using increments other than 64 PN chips, then the extended neighbor list message can be used to instruct the mobile station to scan for those types of base stations, accordingly.

There can be several combinations of delay spread signal strength measurements made available to the location center, from the mobile station 140. In some cases the mobile station 140 may detect up to three to four pilot channels (representing 3-4 base stations), or as few as one signal from one pilot channel.

For each pilot channel detection case, multiple, up to three to four fingers, or multipath signals may be detected per pilot channel.

Note that multiple multipath signals, or multiple "fingers" could exist from a less-strong BS pilot signal, or in any of several combinations, which can depend widely upon the mobile station's location within the base station environment.

By modifying the CDMA Base station, mobile station and controller capabilities to provide the location center 142 with data that exceeds the 1:1 fingers to data receiver correspondence, additional information can be collected and processed in order to further improve the accuracy of the location estimate. A control message from the location center 142 and carried through the network, is sent to the control processor in the mobile station, requiring the searcher receiver in the mobile station o transmit to the location center 142 via the network, all detectable delay spread fingers related to each detectable pilot channel.

In one embodiment the control message is implemented in the CDMA receiver via a multiplexing technique, including appropriate manipulation of the hand-off parameters T_ADDs, T_DROPs, search window and the active, neighbor and remaining pilot sets held within the mobile station' memory.

Although the CDMA ANSI J-STD 008 requires reporting of the pilot channel arrival time in a time period of units of one chip size, or 813.802 nanoseconds, typical CDMA receivers contain an internal Quantization interval of one eighth chip size.

Within the mobile station, by modifying the time of arrival message response message to output the delay value in unit increments of one-eighth chip size, the precision of location accuracy can be increased from about 800 feet in radius to about 110 feet. At the base station the arrival time measurement is forwarded in one-eighth units to the Location Center. A multiplier function applied to the received measurement at the base station rescales the measurement for routine CDMA control and monitoring purposes, in order to be consistent with the CDMA standard. In order to distinguish among several mobile station models which report arrival time in either one-eighth chip units or one chip unit sizes, an encoding can be used in the mobile station's hardware or software identifications, telemetered to the base station and Location Center, in order to determine the arrival time measurement units. In one embodiment the analog receiver in the mobile station utilizes a clock signal which runs eight times faster than the clock originally disclosed in the Gilhousen patent, number 5,109,390. In this manner the digital signal provided to the data receivers and the searcher receiver will include an improved resolution in ability to detect delay spread signals, which are directly used to improve wireless location.

Although the CDMA air interface standard only requires a 1,000 nanosecond tolerance accuracy within respect to the base station, location accuracy can be improved if manufacturing calibration precision's are held to within tighter tolerances, such as less than 250 nanoseconds. However in any given location request, as long as the base station to base station tolerances are tuned properly to an amount less than 500 nanoseconds, then very good location estimates can be performed due to the self canceling time effect geometries typically present in multi pilot channel detection found in urban and suburban areas.

Increasing the typical number of data receivers in either the mobile station or base station provide added capabilities to lock and track more delay spread fingers and respective base station pilot channels. The resulting additional information, if available in a given radio coverage area 120 in Fig. 1, can be used for enhanced location estimate accuracy due to confluence or voting methods which can be deployed at the Location system 142.

In certain cases wireless location signals are received representing distributed antennas (or other base stations) across building floor boundaries being received from a specific floor on a multi-storied building. As a specific example, consider signals are being received from both the 40th and the 41th floor; the objective is to resolve the ambiguity of the situation. Fuzzy logic is used to resolve this ambiguity. The determination as to which floor the user of the mobile station is on is based on the strength of the signal, S, and the past reliability of the information associated with the two antennae, R. The spaces of S and R are discretized using fuzzy sets. The strength is defined as being: (1) VERY STRONG (VS), (2) STRONG (S), (3) WEAK (W), and (4) VERY WEAK (VW) as defined by membership functions. The reliability of information is defined as being: (1) VERY RELIABLE (VR), (2) RELIABLE (R), and (3) NOT RELIABLE (NR), again as defined by membership functions. A fuzzy relation or mapping is described which descretizes how confident it is that the signal is coming for a given floor, e.g., the 40th floor, using the following notation:

| | VS | S | W | VW |
|---|---|---|---|---|
| **VR** | 1.0 | 0.85 | 0.45 | 0.2 |
| **R** | 0.85 | 0.6 | 0.4 | 0.1 |
| **NR** | 0.6 | 0.4 | 0.3 | 0.0 |

The above relation matriz is read, for example, that when the signal information is RELIABLE and the strength is WEAK, then the confidence that the signal is coming from the 40th floor is 0.4. A similiar fuzzy relation matrix is established for the distributed antenna on the 41st floor, and thus the result would be a confidence factor associated with the mobile station being located on either floor. A single solution, that is, whether the mobile station is on the 40th or 41st floor is determined using a compositional rule of inference. The compositional rule of inference is a function that prescribes a mechanism for consolidating mambership function values into a single crisp function. This function can take a variety of forms including max-min composition, max-product composition. etc. The compositional rule of inference can be implemented, for example, by a summing junction which collects the results of each firing rule. The summing junction's output is then provided to a centroidal defuzzier which provides the discretized output.

Fig. 43 indicates the addition of a fuzzy logic module 41 which optionally discretizes the wireless location estimate output from the TOA/TDOA locaton estimator module 8. In the above case fuzzy logic rules related to the distributed antenna relation matrix would be fired or activated as a result of exmining the message header data structure that indicates that the location estimate was the result of a distributed antenna case around the 40th and 41st floor of a particular building within which such fuzzy relations exist or in any other localized case sherin such fuzzy relations have been predetermined. Otherwise, in cases where no such fuzzy rules apply, the location estimate is passed to the recipient without further discretization.

Note that the confidence associated with the location of the mobile station can be considered a function of several variables, not just the two (S and R) described above. For instance, it would not be unreasonable to segregate the reliability information by time signal delay as determined within this invention. The fuzzy relation is capable of handling a variety of such situations. Thus which floor the mobile station is on can be considered to be a function of numerous variables; the ultimate decision can be made based on a great deal of information.

## LOCATION CENTER - NETWORK ELEMENTS API DESCRIPTION

A location application programming interface 14 (Fig. 1), or L-API, is required between the location system's 42 signal processor 20 and the mobile switch center 12 network element type, in order to send and receive various control, signals and data messages for wireless location purposes. The L-API is implemented using a preferably high-capacity physical layer communications interface, such as IEEE standard 802.3 (10 baseT Ethernet), although other physical layer interfaces could be used, such as fiber optic ATM, frame relay, etc. Two forms of API implementation are possible. In the first case the signals control and data messages are realized using the mobile switch center 112 vendor's native operations messages inherent in the product offering, without any special modifications. In the second case the L-API includes a full suite of commands and messaging content specifically optimized for wireless location purposes, which may require some, although minor development on the part of the mobile switch center vendor. A minimum set of L-API message types include:

A first message type, an autonomous notification message from the mobile switch center 112 to the location system 42, is required in the event a wireless enhanced 9-1-1 call has been sent to the mobile switch center from an mobile station 140, including the mobile identification number (MIN), along with various CMRS identification and mobile station detected active, candidate, neighbor and remaining pilot set information, pilot strength measurements message;

A second message type, forward path request-response message, from location system 42 to mobile switch center 112, is required to request a mobile station (MS) for signal measurements and hand-off information, with a response message back from the mobile switch center 112 to the location system 42, along with various CMRS identification;

A third message type, Reverse path request-response message, from location system 42 to mobile switch center 112, to a BS for signal measurements received at the BS and hand-off information, for a given mobile station MIN, along with various CMRS identification. It is preferable for the received signal strength measurements performed at the mobile station along the forward path, and at the base station along the reverse path, to be reported in a variable-length data structure as follows: for each pilot channel offset, include the phase of the earliest arriving usable multipath component pilot PN sequence relative to the zero offset pilot PN sequence of this pilot, termed pilot PN phase or pilot arrival, in units of one-eighth PN chip, instead of units of one PN chip as stated in the standards. Furthermore, in accordance with the standards, the pilot strength shall be included, measured based on at most k usable components, where k is the number of demodulating elements supported by the receiver system. In addition the total number of each detectable multipath components shall be reported. In addition each multipath component, for a given pilot shall be identified by both its delay component and signal strength, for inclusion in the signal measurements to the location system 42. Regarding each individual multipath component, signal strength is expressed as is commonly known, by adding the ratios of received pilot-multhpath component energy per chip, $E_c$, to total received spectral density (noise and signals), $i_c$ of at most that one mutipath component (i.e., k is equal to one).

A fourth message type, an autonomous notification message from the mobile switch center 112 to the location system 42 is required, in the event of an mobile station hand-off state change, along with various CMRS identification.

In order to implement additional location functions such as wide area location, wherein location is determined across roaming boundaries, out-of-coverage area conditions or mobile station 140 turned off, and home base station applications, the L-API must include access to and receive data from a data store contained in the home location register (HLR) network element type associated with the mobile switch center 112.

A fifth message type is required which provides the location system 42 with the mobile station MIN, hand-off, along with various CMRS identification information (e.g., old and new state changes, old and new BS identifications, and hand-offs to another CMRS), roaming location and status changes. A typical communications protocol such as Signaling System number 7, running on a V.35 communications channel could be used for implementation, but numerous other protocols (e.g., TCIP/IP, ROSE, CMISE, etc.) could be used to implement this capability. If the home location register is local to the mobile switch center 112 then the LC - mobile switch center communications link could be used, otherwise a separate communications link is used between the location system 42 and the home location register.

A sixth message type, an autonomous notification message type issued from the location system 42 to the home location register, is required for those location applications they rely on an alert from the home location register when ever a particular mobile station state change occurs, along with various CMRS identification. Consider the case wherein an mobile station 140 whose location is to be tracked constantly. In such cases a history of locations is maintained in the location system 42. Should the mobile station 140 user turn off the power, or exit from the coverage area, then by using previous location values a vector and approximate velocity can be determined. This sixth message type provides a notification message from the home location register to the location system 42 whenever a previously identified mobile station MIN has a state change. Examples of a state changes include cases where the base station 122 discovers the mobile station 140 has traveled to another base station, or that the current primary base station 122 can no longer communicate with the mobile station 140 (i.e., no power), or that a new registration has occurred. In general this message type should support the notification from the home location register to the location system 42 of all messaging and data associated with the nine types of registration, in the case of CDMA. Specifically these include power-up, power-down, timer-based, distance-based, zone-based, parameter-change, ordered, implicit and traffic channel registration. The location system 42 should also be informed of the registration enablement status of each type of registration, which can be provided to the location system 42 via a redirection of the systems parameters message. It should also be possible for the location system 42 to initiate an ordered registration through an order message, from the location system 42 to the mobile switch center 112. The mobile switch center 112 then shall route the message to the appropriate base station, and then to the mobile station. The location system 42 should also be able to receive the results of the message.

In order to implement additional location functions such as providing users with location information and routing instructions to certain locations via the wireless short message text paging service, an L-API is required between the location system 42 and the network element type used to implement the short message service. Such network elements may be termed an intelligent peripheral or a service node. A number of existing paging interfaces have been proposed in standards bodies, and one or more modifications can be made to accommodate L-API content. In any case, the following L-API addition is required: a seventh message type which allows the location system 42 to send a text message containing location information or instructions to a particular mobile station MIN, and a related message to verify response. Optionally another, ninth message type, an autonomous message may be provided to alert the location system 42 under conditions wherein a state change occurs on a previously pending text message. This last message type provides improved quality feedback to the initiating party regarding the acceptance situation of the attempted-to-send page.

**UTILIZING MULTIPLE CMRS INFRASTRUCTURE IN A SHARED COVERAGE AREA**

As a consequence in practical deployment situations that base stations are not placed in a uniform manner in a geographical area, and the fact that variable and fixed clutter introduce a variety of signal measurements which can result in the provision of an ambiguous location estimation, a novel aspect of this patent includes the utilization of the inherent ability of the wireless protocol and receiver design to request and receive signal measurements along the forward and reverse air interface communications path with a given mobile station and other commercial mobile radio service providers, in cases where multiple service providers share a common coverage area. Thus in a coverage area shared by two service providers A and B, utilization of received signal measurements from both service provider A and service provider B can be used by the location center as unique, orthogonal information to both resolve ambiguous location estimates and to further improve the location estimate accuracy.

The CDMA air interface, for example, provides a soft hand-off capability for the mobile station to hand-off a voice communication channel to another base station, and even to another CMRS provider, termed a hard hand-off.

Referring to Fig. 3, assume three sectored base stations 122a, 122b, and 122c, in communication with mobile switch center-A 112a, are owned and operated by CMRS provider A. Further, assume three sectored base stations 122d and 122e, in communication with mobile switch center-B 112b, are owned and operated by CMRS provider B, and that the coverage area with CMRS-A and CMRS-B substantially overlap. In order to locate a mobile station 140 whose subscriber normally does business with CMRS provider A, assume that the receiver of mobile station 140 can detect signals from base stations 122a, 122b, and 122c, as well as from base stations 122d and 122e, although normal mode use would preclude such measurements from being initiated. Assume further that the resulting location estimate 131, generated from the location center 120 contains either an ambiguous location estimate value pair, or otherwise cannot render a location estimate with the desired range of accuracy.

From an inspection of the overall base station geometry of base stations owned by CMRS A and CMRS B it is evident that a strong possibility exists that either 1.) the receivers in mobile station 140 have the possibility to detect the pilot channels associated with base stations 122d and 122e; 2.) the receivers in base stations 122d and 122e have the possibility to detect the transmitter signal from mobile station 140. The location system 142 contains a data store of both CMRS provider's base station geometeries and is in communication with each mobile switch center - A 112a and mobile switch center - B 112b. An application in the location system 142 sends a control message to the mobile station 140, instructing the mobile station to tune its searcher receiver to listen for and report back signal measurement data regarding the pilot channel information associated with base stations 122d and 122e, in addition to a request to report of pilot signals relative to base stations 122a, 122b, and 122c. Similarly the application in the location system 142 sends messages to each of base stations 122d and 122e, with instructions to take signal measurements and report back the resulting information regarding the mobile stations transmitter 140. Since the signaling information from base stations 122d and 122e are based on a substantially different location geometry, the resultant information is orthogonal and thus can be used by the location center to provide enhanced location estimates.

If appropriate, a variation of the above process includes a location center initiated forced hard hand-off of the mobile station from a primary base station, e.g., 122b associated with CMRS-A, to a new primary base station associated with CMRS-B, e.g., 122d. A forced hand-off will further provide improvements in reducing systemic timing errors which may be inherent among base stations owned by different CMRS. After the appropriate signal measurements have been reported the location system 142 can revert the hand-off back to the original CMRS. Other location system components shown in Fig. 3 include a controller 14 location applications programming interface 136 (L-API-MSC) for communications interface with multiple CMRS mobile switching centers, via physical interfaces 176a and 176b.

In order to provide the most economically efficient and accurate wireless location service capabilities among multiple CMRS providers in a shared coverage area, a common location applications programming interface (L-API) is highly desirable. A common interface also supports the natural competitive behaviors among wireless consumers and CMRS by providing flexible relationships among consumers who may want to switch service providers, yet retain consistent wireless location services for public safety. This approach minimizes the L-API design and deployment costs among infrastructure vendors and location service providers in a shared coverage area. Based on a L-API between a wireless location center and the mobile switch centers of multiple CMRS, a novel aspect of this invention further includes a method and process that provides account management clearing house and revenue settlement capability with appropriate security management controls. This capability is implemented as wireless location control, accounting and security mediation agent functions to compensate CMRS providers for providing various location-specific network services as described herein.

As wireless location requests are sent to the location center for a given CMRS, operated by a wireless location service provider (WLSP), this agent: 1.) assesses the appropriateness of soliciting additional signal and control measurements from another CMRS' base station in the same coverage area, in order to improve the quality of the location estimate, 2.) Accesses, requests and receives signal and control information with another CMRS base station infrastructure, 3.) provides as appropriate a record of compensation entitlement between or among multiple CRMS and WLSPs, and 4.) security management controls that protect the privacy needs of wireless customers and the unauthorized sharing of information between or among CMRS. Security controls also include audit trails and controls regarding customer access of their location subscriber profile and the administration of network security processes and related base station parameters and inventory.

Referring to Fig. 5, Location Center-base station access, multiple CMRS, an alternative embodiment is provided to extract the wireless location signal measurement data from each base station associated with each of multiple CMRS. Given base station 122i and 122j are operated by CMRS-A and base station 122k and 122m are operated by CMRS-B, a communication circuit provides connectivity with the location application programming interface - base station (L-API-BS) 109. The L-API-BS 109 is in communication with controller 14 in the location center 142. The communications circuit can be any of several conventional transport facilities, such as a private line circuit, a DS-1 or T-1 carrier circuit, frame relay circuit, microwave circuit, or other data communications circuit.

The advantage of this embodiment is that no modifications are required by the infrastructure vendor in terms of the embedded operations circuit, and related functions and systems which otherwise would be needed to telemeter wireless location signal measurement data from the base station to the location center 142. The termination equipment (not shown) in communication with the transport facilities, within each base station typically includes a small computer with an in-circuit connection, such as an ASIC clip-on device, with connections to the control processor circuitry with the base station in the receiver section. The small computer provides a conversion of the signals provided on the in-circuit connection to the ASIC chip, for serialization and transmission to the location center via the transport facilities.

## HOME BASE STATION DESCRIPTION

The Home Base station (HBS) concept in the PCS wireless network environment allows a user's mobile station to be also used as a low cost cordless phone, whenever the mobile station is physically near (generally within 700-1,000 feet) of a Home Base station Device (HBSD). This enables the user to avoid the typically higher cost air time charges associated with traditional wireless service.

The HBSD is similar to ordinary cordless phone transceiver devices in current use today, but is modified to function with a PCS wireless mobile station. Although the HBSD has been typically used at a residential consumer's home, the HBSD could also be used in business settings and other environments.

When a mobile station (MS) is near the HBSD as shown in Fig. 17, and the HBSD detects the presence of a mobile station over the Cordless phone air interface, the HBSD signals the Home Location Register (HLR) software in the Service Control Point in the AIN network associated with the mobile station and mobile station's home mobile switch center. The home location register redirects mobile station terminating calls from the network away form the mobile station' mobile identification number in the mobile switch center, and to the AIN/SSP wireline class V switch which connects the wireline number associated with the HBSD. Similarly, the HBSD, upon detecting a mobile station call origination attempt, redirects the mobile station signal from a PCS network fixed base station, to the control of the HBSD. The HBSD redirects the mobile station originating call through the wireline network, similar to any other wireline network call.

A reverse scenario occurs whenever the mobile station and HBSD lose communication: the mobile station registers in a wireless PCS network fixed base station, causing redirection of calls to the wireless network. The cordless phone air interface may be of a vendor proprietary design, or it may be a similar design as the CDMA air interface.

In order to perform a location estimate in the HBS concept, a connection is used between the Location Center (LC) and the home location register/HBS application in the SCP. In addition, a new process, termed a Location Notification Process (LNP) within the home location register/SCP is used to send a message to the LC, autonomously whenever a state change occurs in the mobile station' (either via a specific list of mobile identification numbers or all mobile identification numbers) registration: registering either to a fixed Base station in the Wireless PCS network or to a HBSD.

Alternatively the process may respond to an on-demand message from the LC to the LNP within the home location register/HBS application. In either case a response message from the LNP to the LC provides the information regarding whether or not a mobile station is within range of its, or a designated HBSD. In either case the response message contains a message header information which provides the signal processing subsystem 20 (equivalently this may be known by signal filtering subsystem) with the ability to determine and distribute the information to the HBS First Order Location Estimate Model.

## LOCATION USING DISTRIBUTED ANTENNAS DESCRIPTION

CDMA distributed antennas are useful particularly in system configurations involving microcells, and potentially indoor environments, such as CDMA PBX (private branch exchange) systems in business offices, and in wireless local loop applications. From a mobile station location perspective, the distributed antenna configuration can provide significant improvements in location error, as compared with an indoor mobile station user with a wireless connection to an outdoor, macrocell Base station. Wireless location can be achieved provided certain methods and procedures (M&Ps) are followed during the installation process. Data related to these M&Ps is then used by various location processes discussed elsewhere in this invention.

First, a general description of CDMA distributed antennas is presented, followed by the M&Ps necessary to support wireless location.

In the CDMA distributed antenna concept, a set of simple antennas, placed apart in a given area, similarly to any other cell placement arrangement for coverage objectives, are fed by a common radio signal. Antennas are usually placed such that their coverage patterns are substantially or completely overlapped in area of coverage. From a wireless location perspective, completely overlapping coverage is preferred (this approach also improves perceived signal quality by the end users).

The importance of understanding and characterizing the aggregate system delay elements is shown in Fig. 6: Distributed Antenna Delay Characterization. For any given Pilot Channel offset "I", additional delay is introduced by the microwave propagation channel (Point A) and any internal repeater/amplifier equipment (Point B). Each of four delay elements $t_1$ through $t_4$ introduce further delay. A mobile station detecting all four DA antennas' delayed signals would determine various sets of cumulative system propagation delays. Since each delay is essentially fixed in a location, such information can be used to determine the mobile station location within the building. Fig. 7 illustrates the effective system timing among the delay elements 324, relative to the GPA system time 336, along each point in the diagram shown in Fig. 6.

Fig. 9: One Exemplary DA Configuration, illustrates a typical configuration where the CDMA base station antenna is also directed connected to three delay elements and antenna radiators.

The CDMA Base station transmitter common output signal is fed through a distribution coaxial cable system, optical fibers or other means, to a string of two or more antennas. Each antenna is connected to the distribution cable via a transmission line tap or delay element, which may or may not provide further broadband gain. The transmission system normally consists of two media channels, one for transmit and one for receive signals. Fig. 10 illustrates an Alternative DA Configuration, using multi-point microwave antennas connected to individual delay elements and their respective radiating antennas.

Fig. 11: Serving Dense Multi-level buildings via Virtual Pilots, illustrates a typical application where a multi-level building is served by two base stations with pilot offsets "I" and "j". Pilot offset "I" serves floor X and pilot offset "j" serves floor Y. As shown, a microwave link, either active or passive, relays the base station signals between the distributed antennas within the building to the base stations.

The main concept is to introduce purposeful delay and multipath signals with sufficient delay spread for signal discrimination. Each antenna radiates a signal which is substantially delayed with respect to any other antenna in the area. If two or more paths are available for the mobile station receivers with greater than one eighth microsecond differential path delay (or whatever resolution is available in the CDMA mobile station receivers), then two or more PN receivers in the same mobile station can be employed to separately receive and combine these signals and thus achieve processing gains through path diversity. Antennas may be omni-directional or directional.

Delay elements may be simple delay lines such as lengths of coaxial cabling, or other active or passive delay elements, such that the combination of components provides the needed delay. The transmission line between the CDMA Base station/PBX and the distributed antennas may be via a pair of dedicated, beam-focused high gain antennas, and/or a repeater system. Provided sufficient delay exists between the multipath signals from separate distributed antennas exists, each Data Receiver within the mobile station tracks the timing of the received signal it is receiving. This is accomplished by the technique of correlating the received signal by a slightly earlier reference PN and correlating the received signal with a slightly late local reference PN. Further distributed antenna details can be seen from Gilhousen, et al, patent number 5,280,472, assigned to Qualcomm, Inc.

The total measured delay of both forward and reverse link signals between the BS and the mobile station are thus determined naturally by the CDMA radio receiver designs as a part of the multipath tracking process, and can be made available to a location entity for performing location estimates of the mobile station.

However, the measurements of delay between a particular distributed antenna and the mobile station will include the aggregate delay components of several mechanisms, beyond the BS pilot PN offset delay. In the case of distributed antenna configurations, the simple TOA or TDOA model which is based solely of the speed of light, must now be adjusted to account for the purposefully introduced delay.

The mobile station measures the arrival time $T_i$ for each pilot /reported to the BS. The pilot arrival time is the time of occurrence, as measured at the mobile station antenna connection, of the earliest arriving usable multipath of the pilot. The arrival time is measured relative to the mobile station' time reference in units of PN chips. The mobile station computes the reported pilot PN phase $f_i$ as:

$$f_i = (T_i + 64 \times \text{PILOT\_PN}) \bmod 2^{15},$$

where PILOT_PN is the PN sequence offset of the pilot.

Reference Fig. 6, which illustrates a typical distributed antenna configuration consisting of a repeater/amplifier and four distributed antennas. The total system delay, $T_i$ is:

$$T_i = T_{offset} + T_0 + T_R + T_1 + T_2 + T_3 + T_4$$

During the installation phase of the high gain antenna (if required), repeater (if required) and the distributed antennas, if the system delay is measured at each distributed antenna and the values stored in a location database, including each antenna identification, and exact physical location (in three dimensions), then during a location request, all fixed delays will be known, thus the TP value can be determined by subtracting the fixed, known delay values from Ti, the measured time of arrival. The TP value can now be used to determine a TOA and or a TDOA value in a manner similar to the non-distributed antenna case, thus location can be determined based on these TOA/TDOA ranging values.

The required installation methods and procedures required to support wireless location are illustrated in Fig. 8: Methods and Procedures for DA Installation. By following these methods, the Location Center (LC) will contain a database populated with the necessary data values to perform accurate location estimates within the building containing the distributed antennas. Fig. DA-10: Exemplary DA Location Database, illustrates typically data element types and values required in the DA location estimate model database. Fig. DA-11 illustrates how a simple TOA location estimate model can be used to determine wireless location in a DA environment. Based on the known geometry and coverage areas of each DA cell, and the percentage of maximum radius, determined by the above classification, it is possible to construct radius-radius circles of the DA cells. The intersection of the three circles (in this case) provides the location estimate.

In order for the TOA and TDOA location calculations to be determined, it is a necessary condition that during distributed antenna installation, the minimum values of the Delay Elements be set to each exceed the maximum practical (i.e., within the coverage area) TP values be at least 1/2 of a PN chip duration (about 500 nanoseconds), to easily allow for the CDMA Data Receivers to be able to correlate between the delay element values and the TP delay values. Fig. 12: DA Delay Spread Ranges, illustrates typical maximum ranging variable delay values (e.g., up to 1,960 feet) if 500 nanosecond guard zones (t) are used. If larger ranging values are required, then guard zone delays must be increased proportionally.

Fig. 13: DA Cell Layout and Geometry, illustrates, for DA omnicell sizes with a radius of about 2,000 feet and guard zones of 500 nanoseconds, that the minimum required cumulative delay values for the delay elements are: $t_2 = 2.46$ microseconds, $\mathbf{t_3} = 4.92$ mS, and $\mathbf{t_4} = 7.38$ mS, respectively.

It should also be noted that a maximum upper bound exists for the maximum amount of cumulative system propagation delay which can be tolerated by the CDMA mobile station. The total delay cannot exceed an amount that would interfere with the next pilot PN offset, or substantially delay the scanning time of the search receiver in the mobile station. In any case, 30 to 40 microseconds of total delay is acceptable, and would allow for a relatively large number of distributed antenna components to be included, thus no unusual impacts are required of the system to accommodate location methods.

By purposefully introducing a relatively large amount of delay in the distributed antenna delay elements, relative to the maximum permissible TP delay values, it is possible to utilize the large Delay Element values to uniquely identify the distributed antenna ID, and thus via the distributed antenna database, to determine the antennas' exact location. Knowing the antenna's location and TP value (last stage of propagation delay), TOA and TDOA ranging can be achieved, and thus mobile station location within a distributed antenna configuration, can be determined.

Fig. 14: Actual Measurements and Classification, illustrates how CDMA delay spread measurements are used in a DA configuration to form a relationship with the mobile station location with respect to the DA locations. Although the CDMA air interface standard only requires the signal strength and time of arrival of the first useable delay spread signal to be reported from the mobile station to the BS, assume here that the mobile station has the capability to provide the BS, and consequently the LC, with a list of all peak values of CDMA fingers.

Assume that the mobile station detects and telemeters three CDMA finger RF measurements, as shown in the table below, New Message Type Data Structure Content.

| Signal Strength | Delay Time of Arrival |
|---|---|
| -77 dBm | 1.68 microseconds |
| -66 | 3.98 |
| -95 | 9.16 |

Table: New Message Type Data Structure Content.

Note that the measurements may be averaged over a sample space of 128 individual measurements. Referring now back to Fig. 14, it can be seen that the first finger is associated with the DA cell-1, range 0 to 1.96 microseconds, and DA cell-2, range 2.46 microseconds to 4.42 uS, and DA cell-4, range 7.38 to 9.34 uS. Since the DA cell antennas are fixed, with known locations, correlation's can be derived and established to relate actual measurements with locations. Any one of several location estimate modules may be used, as shown in Fig. DA-12: Location Estimate using the radius-radius method, or multiple invocations of different modules may alternatively be used to form a location estimate of the mobile station within the DA environment.

It is now possible to classify the above actual measurements as propagation delayed signals for the DA cells 1, 2, and 4, since each DA cell delay range is know, and sufficient guard zones exist between delay spread ranges to unambiguously classify the measurements, and thus to determine mobile station location. The following table illustrates a typical database containing the classification columns for each DA cell and their corresponding location in an x,y plane.

| DA Cell ID | Location (X, Y) in feet) | DA Cell Radius | Low Range ( microseconds) | High Range (In microseconds) |
|---|---|---|---|---|
| 1 | (0,0) | 1.96 | 0 | 1.96 |
| 2 | (-20, 3000) | 1.96 | 2.46 | 4.42 |
| 3 | (4000, 2800) | 1.96 | 4.92 | 6.88 |
| 4 | (1600, 2800) | 1.96 | 7.38 | 9.34 |

Table: New Message Type Data Structure Content

Translating the actual delay measurements into a percentage of the maximum radius of each cell (i.e., cell 1 radius actual is 88 %, cell 2 radius actual is 78 %, and cell radius 4 actual is 91%) provides wireless location using familiar radius-radius calculations.

Depending upon the combinations of embodiments, the Location Center and Gateway may contain from one to three interfaces into the digital PCS network, shown as interfaces X, Y, and Z, in Fig. 24, Location and CTIA/TR45 Network Reference Model. Network interface reference points Um, A, Ai, B, C, D and H are part of the Cellular Telecommunications Industry of America (CTIA)/Technical Reference 45 standards, and are not discussed further.

Network interface reference point X provides a direct connection to the mobile switch center, used for transferring RF measurement signals from the mobile station and BS to the LC and for transferring location control between the LS and mobile station, and between the LC and BS. This interface can be implemented via any number of data communications circuit configurations and protocols in current use, such as a T-carrier data circuit, with DSU/CSUs at each end, using an intranet/internet protocol suite, such as TCP/IP, RPC messaging, or other middleware solutions, such as Pipes, IBM MQ series, world wide web protocols, such as JAVA/VRML scripts, hypertext markup language (HTML) links, and may also include various firewall schemes and data encryption mechanisms, etc., in order to communicate asynchronous messaging among the endpoints, and in particular, in reference to the final distribution of the location information to the desired end user.

Network interface reference point Y is used in the embodiment wherein a public switched telephone network interface is required or desired. This interface is a straightforward method to support location applications wherein, for example, a mobile station user dials a telephone number in order to initiate a location request, and could also be used to telemeter RF measurement and location control messages between the LC and the mobile station/BS. Alternatively a timer-initiated process internal to the LC may be used to start a location request, or via any number of events external to the network. Point Y also has the advantage of not requiring a direct connection to a commercial radio mobile service providers' network elements, thus affording a convenient interface for use by third party location service providers unrelated to the commercial radio mobile service provider.

## NATIONAL SCALE WIRELESS LOCATION

By utilizing specific data items used in the Home Location Register in the Advanced Intelligent Network, it is possible to determine the mobile station location on a national scale, i.e., location within the context of a state, and in which city.

Network interface reference point Z is used in the embodiment wherein a gross location must be determined. A gross location is defined as an area associated with a particular mobile switch center coverage area. Mobile switch center coverage areas are typically bounded by a large metropolitan area, such as a city. The Home Location Register (HLR) contains gross location information. The Z interface allows the LC to query the home location register to determine if the user is in their "home area, or whether the user is roaming to another mobile switch center coverage area, such as another city. IS-41 Cellular Radio Telecommunications intersystem operations communications protocols provide mechanisms that allow a user to roam into authorized areas outside of their "home" area.

If the user is roaming in another area, then the LC can use that information to initiate location control messages toward the CDMA network currently hosting the mobile station user. Fig. 25 illustrates how a user based in Los Angeles, CA, for example, may roam to a CDMA system New York City, and be "located" within that metropolitan area, through a data communications network and a national Location Center Clearinghouse system.

## SIGNAL PROCESSOR SUBSYSTEM

The signal processing subsystem receives control messages and signal measurements and transmits appropriate control messages to the wireless network via the location applications programming interface referenced earlier, for wireless location purposes. The signal processing subsystem additionally provides various signal idintification, conditioning and pre-processing functions, including buffering, signal type classification, signal filtering, message control and routing functions to the location estimate modules.

There can be several combinations of Delay Spread/Signal Strength sets of measurements made available to the signal processing subsystem 20 within the Location Center/System 42, shown in Fig. 3. In some cases the mobile station 140 may be able to detect up to three or four Pilot Channels representing three to four Base Stations, or as few as one Pilot Channel, depending upon the environment. Similarly, possibly more than one BS 122 can detect a mobile station 140 transmitter signal, as evidenced by the provision of cell diversity or soft hand-off in the CDMA standards, and the fact that multiple CMRS' base station equipment commonly will overlap coverage areas. For each mobile station 140 or BS 122 transmitted signal detected by a receiver group at a station, multiple delayed signals, or "fingers" may be detected and tracked resulting from multipath radio propagation conditions, from a given transmitter.

In typical spread spectrum diversity CDMA receiver design, the "first" finger represents the most direct, or least delayed multipath signal. Second or possibly third or fourth fingers may also be detected and tracked, assuming the mobile station contains a sufficient number of data receivers. Although traditional TOA and TDOA methods would discard subsequent fingers related to the same transmitted finger, collection and use of these additional values can prove useful to reduce location ambiguity, and are thus collected by the Signal Processing subsystem in the Location Center 142.

For each pilot channel detection case, multiple fingers (up to three or four) may be detected and thus reported to the Location system, as shown in Fig. 22 and 23, for dense urban and rural settings, respectively. From the mobile receiver's perspective, a number of combinations of measurements could be made available to the Location Center. Table SP-1 illustrates the available combinations for three and four receiver cases, respectively.

| No. of Receivers | No. of BSs detected | No. of Fingers Detected | No. of Fingers, BS 1-S (first strongest) | No. of Fingers, BS 2-S (second strongest) | No. of Fingers, BS 3-S (third strongest) | No. of Fingers, 4-S (fourth Strongest |
|---|---|---|---|---|---|---|
| 3 | 1 | 1 | 1 | 0 | 0 | 0 |
| 3 | 1 | 2 | 2 | 0 | 0 | 0 |

| No. of Receivers | No. of BSs detected | No. of Fingers Detected | No. of Fingers, BS 1-S (first strongest) | No. of Fingers, BS 2-S (second strongest) | No. of Fingers, BS 3-S (third strongest) | No. of Fingers, 4-S (fourth Strongest |
|---|---|---|---|---|---|---|
| 3 | 1 | 3 | 3 | 0 | 0 | 0 |
| 3 | 2 | 2 | 1 | 1 | 0 | 0 |
| 3 | 2 | 3 | 2 | 1 | 0 | 0 |
| 3 | 2 | 3 | 1 | 2 | 0 | 0 |
| 3 | 3 | 3 | 1 | 1 | 1 | 0 |
| 4 | 4 | 4 | 1 | 1 | 1 | 1 |
| 4 | 3 | 4 | 1 | 2 | 1 | 0 |
| 4 | 3 | 4 | 1 | 2 | 1 | 0 |
| 4 | 3 | 4 | 2 | 1 | 1 | 0 |
| 4 | 2 | 4 | 3 | 1 | 0 | 0 |
| 4 | 2 | 4 | 2 | 2 | 0 | 0 |
| 4 | 2 | 4 | 1 | 3 | 0 | 0 |
| 4 | 1 | 4 | 4 | 0 | 0 | 0 |

**Table SP-1: Nominal CDMA Location Measurement Combinations**

The above Table SP-1 scenario assumes that the mobile station design and data collection structure only permits a 1:1 correspondence to exist between the number of base stations detected and the number of data receivers reporting multipath CDMA fingers.

Table SP-1 illustrates the potential combinations of detected CDMA signals representing multipath fingers and total number of detectable base station pilot signals in a given location within the radio coverage area 120. Due to the disperse and near-random nature of CDMA radio signals and propagation characteristics, traditional TOA/TDOA location methods have failed in the past, because the number of signals received in different locations area different. In a particularly small urban area, say less than 500 square feet, the number of RF signals and there multipath components may vary by over 100 percent.

The following diagrams illustrate a certain case from a location measurement perspective, of signals received for a three -data receiver and a four-data receiver configuration, in a nominal three sector honeycomb base station configuration. In Fig. 18, a mobile station at location "A" detects base stations 1b, 5c, and 4a. However although a triad of signals are received, if varying multipath signals are received from one or more base stations, then ambiguity can still result. Fig. 19 illustrates a mobile station located at position "A", detecting base stations 1b, 5c, 4a, and 2c. Although additional information is made available in this second case, traditional hyperbolic combinations taken three at a time, yield multiple location estimates. In certain cases the limit of the back-side of a "far-away"sectored antenna can be used to determine the limit of RF coverage in another base station sector area.

Fig. 20 shows that normally a delay spread in sector 1b would imply a range of a 120 degree solid angle. However by using the known fact that base station sector 2a contains a coverage limit, such negative logic can be used to further restrict the apparant coverage area in sector 1b, from 120 degrees to approximately 90 degrees as shown in the illustration, in order to locate the mobile station B. Such information regarding sector 2a can be determined by collecting the remaining set information from mobile station B.

Now consider more practical, less ideal cases. Due to the large capital outlay costs associated with providing three or more overlapping base station coverage signals in every possible location, most practical digital PCS deployments result in fewer than three base station pilot channels being reportable in the majority of location areas, thus resulting in a larger, more amorphous location estimate. Fig. 20 and 21 illustrate a typical relative error space wherein a mobile station detects only two base station pilot channels, and only one pilot channel, respectively. This consequence requires a family of location estimate location modules, each firing whenever suitable data has been presented to a model, thus providing a location estimate to a backend subsystem which resolves ambiguities.

Base Station Cell site planning tools which utilize antenna gain radiation patterns, environmental clutter, such as buildings, dense forests, terrain heights, etc., can provide reasonable training data to bootstrap the initial operation of the LC.

An example of the types of data typically collected during field tests/runs is shown in the following database table SP-2 below:

| **Column Position** | **Mobile Data Test Set: Data Type Logged** |
|---|---|
| 1 | CDMA Time (absolute, from GPS) |
| 2 | Vehicle Speed (in mph) |
| 3 | Vehicle Latitude (in deg. North) |
| 4 | Vehicle Longitude (in deg. East) |
| 5 | GPS Source (binary, e.g., GPS or Dead Reckoning) |
| 6 | GPS Data available indicator (binary states) |
| 7 | First BS-Mobile Received Power (in dBm, 1 second averages) |
| 8 | Mobile transmit Gain Adjust (in dBm, 1 second average) |
| 9 | First BS Mobile Rx Pilot $E_c/I_o$ (dB, 1 second average) |
| 10 | First BS Mobile received Frame Counts (integers per measurement period) |
| 11 | Mobile Finger's Average Time Separation (in nano/microseconds) |
| 12 | Mobile Fingers' Maximum Time Separation (in nano/microseconds) |
| 13 | Mobile Fingers' Number of Pilots locked (per 1 second average) |

| Column Position | Mobile Data Test Set: Data Type Logged |
|---|---|
| 14 | Mobile finger Lock Counts |
| 15 | First BS Received Frame Counts |
| 16 | First BS Eb/No set Point (in dB, 1 second average) |
| 17 | First BS cell Rx Eb/No per antenna (in dB, 1 second average) |
| 18 | Hand-off State (relative to the First, or connected-to BS) |
| 19 | First BS Traffic Channel Gain |
| 20 | First BS Power Control Subchannel Gain |
| 21 | First BS Reverse Link full Frame Error Rate, over 500 frames |
| 22 | Forward Link full Frame Error Rate, over 500 frames |
| 23 | First BS Pilot Channel Delay Spread (in nanoseconds) |
| 24 | Second BS-Ranked Pilot Delay Spread (in nanoseconds) |
| 25 | Second BS-Ranked Pilot Relative Signal Strength (in dB) |
| 26 | Third BS-Ranked Pilot Delay Spread |
| 27 | Third BS-Ranked Pilot Relative Signal Strength (in dB) |
| 28 | Mobile Antenna Identification (in the case of a multi-sectored antenna) |
| 29 | Vehicle compass orientation (bearing or heading) |
| 30 | Mobile Station Power Class (an integer, 0-7, indicating max. power capabilities of the mobile station transmitter) |

**Table SP-2: Typical CDMA Field Test Measurements**

Although the forward link mobile station's received relative signal strength ($RRSS_{BS}$) of detected nearby base station transmitter signals can be used directly by the location estimate modules, the base station's reverse link received relative signal strength ($RRSS_{MS}$) of the detected mobile station transmitter signal must be modified prior to location estimate model use, since the mobile station transmitter power level changes nearly continuously, and would thus render relative signal strength useless for location purposes.

One adjustment variable and one factor value are required by the signal processing subsystem: 1.) instantaneous relative power level in dBm (IRPL) of the mobile station transmitter, and 2.) the mobile station Power Class. By adding the IRPL to the $RRSS_{MS}$, a synthetic relative signal strength ($SRSS_{MS}$) of the mobile station 140 signal detected at the BS 122 is derived, which can be used by location estimate model analysis, as shown below:

$$SRSS_{MS} = RRSS_{MS} + IRPL \qquad \text{(in dBm)}$$

$SRSS_{MS,}$ a corrected indication of the effective path loss in the reverse direction (mobile station to BS), is now comparable with $RRSS_{BS}$ and can be used to provide a correlation with either distance or shadow fading because it now accounts for the change of the mobile station transmitter's power level. The two signals $RRSS_{BS}$ and $SRSS_{MS}$ can now be processed in a variety of ways to achieve a more robust correlation with distance or shadow fading.

Although Rayleigh fading appears as a generally random noise generator, essentially destroying the correlation value of either $RRSS_{BS}$ or $SRSS_{MS}$ measurements with distance individually, several mathematical operations or signal processing functions can be performed on each measurement to derive a more robust relative signal strength value, overcoming the adverse Rayleigh fading effects. Examples include averaging, taking the strongest value and weighting the strongest value with a greater coefficient than the weaker value, then averaging the results. This signal processing technique takes advantage of the fact that although a Rayleigh fade may often exist in either the forward or reverse path, it is much less probable that a Rayleigh fade also exists in the reverse or forward path, respectively. A shadow fade however, similiarly affects the signal strength in both paths.

At this point a CDMA radio signal direction-independent "net relative signal strength measurement" is derived which is used to establish a correlation with either distance or shadow fading, or both. Although the ambiguity of either shadow fading or distance cannot be determined, other means can be used in conjunction, such as the fingers of the CDMA delay spread measurement, and any other TOA/TDOA calculations from other geographical points. In the case of a mobile station with a certain amount of shadow fading between its BS 122 (Fig. 2), the first finger of a CDMA delay spread signal is most likely to be a relatively shorter duration than the case where the mobile station 140 and BS 122 are separated by a greater distance, since shadow fading does not materially affect the arrival time delay of the radio signal.

By performing a small modification in the control electronics of the CDMA base station and mobile station receiver circuitry, it is possible to provide the signal processing subsystem 20 (reference Fig. 1) within the Location system 42 (Fig. 1) with data that exceed the one-to-one CDMA delay-spread fingers to data receiver correspondence. Such additional information, in the form of additional CDMA fingers (additional multipath) and all associated detectable pilot channels, provides new information which is used to enhance to accuracy of the Location Center's location estimate location estimate modules.

This enhanced capability is provided via a control message, sent from the Location system 42 to the mobile switch center 12, and then to the base station(s) 122 (Fig. 2) in communication with, or in close proximity with, mobile stations 140 to be located. Two types of location measurement request control messages are needed: one to instruct a target mobile station 140 (i.e., the mobile station to be located) to telemeter its BS pilot channel measurements back to the primary BS 122 and from there to the mobile switch center 112 and then to the location system 42. The second control message is sent from the location system 42 to the mobile switch center 112, then to first the primary BS 122, instructing the primary BS' searcher receiver to output (i.e., return to the initiating request message source) the detected target mobile station 140 transmitter CDMA pilot channel offset signal and their corresponding delay spread finger (peak) values and related relative signal strengths.

The control messages are implemented in standard mobile station 140 and BS 122 CDMA receivers such that all data results from the search receiver and multiplexed results from the associated data receivers are available for transmission back to the Location Center 142. Appropriate value ranges are required regarding mobile station 140 parameters $T\_ADD_s$, $T\_DROP_s$, and the ranges and values for the Active, Neighboring and Remaining Pilot sets registers, held within the mobile station 140 memory. Further mobile station 140 receiver details have been discussed above.

In the normal case without any specific multiplexing means to provide location measurements, exactly how many CDMA pilot channels and delay spread fingers can or should be measured vary according to the number of data receivers contained in each mobile station 140.

As a guide, it is preferred that whenever RF characteristics permit, at least three pilot channels and the strongest first three fingers, are collected and processed.

From the BS 122 perspective, it is preferred that the strongest first four CDMA delay spread fingers and the mobile station power level be collected and sent to the location system 42, for each of preferably three BSs 122 which can detect the mobile station 140.

Table SP-3 illustrates the resulting extended combinations of BS signals (pilot channels) and finger measurements potentially available, based on the above preferred conditions. The philosophy is to collect as much reasonable data as is practical, given the constraints of CDMA receivers, search times, receiver memory storage and available CPU and data transmission bandwidth, in order that sufficient orthogonal information can be processed to minimize location estimate error.

| No. of Receivers | No. of BSs detected | No. of Fingers Detected | No. of Fingers, BS 1-S (first strongest) | No. of Fingers, BS 2-S (second strongest) | No. of Fingers, BS 3-S (third strongest) | No. of Fingers, 4-S (fourth Strongest |
|---|---|---|---|---|---|---|
| 3 | 1 | 1 | 1 | 0 | 0 | 0 |
| 3 | 1 | 2 | 2 | 0 | 0 | 0 |
| 3 | 1 | 3 | 3 | 0 | 0 | 0 |
| 3 | 2 | 2 | 1 | 1 | 0 | 0 |
| 3 | 2 | 3 | 2 | 1 | 0 | 0 |
| 3 | 2 | 3 | 1 | 2 | 0 | 0 |
| 3 | 2 | 4 | 2 | 2 | 0 | 0 |
| 3 | 2 | 5 | 2 | 3 | 0 | 0 |
| 3 | 2 | 5 | 3 | 2 | 0 | 0 |
| 3 | 2 | 4 | 3 | 1 | 0 | 0 |
| 3 | 2 | 4 | 1 | 3 | 0 | 0 |
| 4 | 2 | 5 | 4 | 1 | 0 | 0 |
| 4 | 2 | 5 | 1 | 4 | 0 | 0 |
| 3 | 3 | 3 | 1 | 1 | 1 | 0 |
| 3 | 2 | 6 | 3 | 3 | 0 | 0 |
| 3 | 3 | 3 | 1 | 1 | 1 | 0 |
| 3 | 3 | 4 | 2 | 1 | 1 | 0 |
| 3 | 3 | 4 | 1 | 2 | 1 | 0 |
| 3 | 3 | 4 | 1 | 1 | 2 | 0 |
| 3 | 3 | 5 | 2 | 2 | 1 | 0 |
| 3 | 3 | 5 | 2 | 1 | 2 | 0 |
| 3 | 3 | 5 | 1 | 2 | 2 | 0 |
| 3 | 3 | 6 | 2 | 2 | 2 | 0 |
| 3 | 3 | 6 | 3 | 2 | 1 | 0 |
| 3 | 3 | 6 | 2 | 3 | 1 | 0 |
| 3 | 3 | 6 | 1 | 2 | 3 | 0 |
| 3 | 3 | 6 | 1 | 3 | 2 | 0 |
| 4 | 4 | 4 | 1 | 1 | 1 | 1 |
| 4 | 4 | 5 | 2 | 1 | 1 | 1 |
| 4 | 4 | 5 | 1 | 2 | 1 | 1 |
| 4 | 4 | 5 | 1 | 1 | 2 | 1 |
| 4 | 4 | 5 | 1 | 1 | 1 | 2 |
| 4 | 4 | 6 | 2 | 2 | 1 | 1 |
| 4 | 4 | 6 | 2 | 1 | 2 | 1 |
| 4 | 4 | 6 | 1 | 1 | 2 | 2 |
| 4 | 4 | 6 | 1 | 2 | 2 | 1 |
| 4 | 4 | 6 | 1 | 2 | 1 | 2 |
| 4 | 4 | 6 | 2 | 1 | 1 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | 4 | 7 | 3 | 2 | 1 | 1 |
| 4 | 4 | 7 | 3 | 1 | 2 | 1 |
| 4 | 4 | 7 | 2 | 3 | 1 | 1 |
| 4 | 4 | 7 | 2 | 1 | 3 | 1 |
| 4 | 4 | 7 | 2 | 1 | 1 | 3 |
| 4 | 4 | 7 | 1 | 3 | 2 | 1 |
| 4 | 4 | 7 | 1 | 2 | 3 | 1 |
| 4 | 4 | 7 | 1 | 1 | 2 | 3 |
| 4 | 4 | 7 | 1 | 1 | 3 | 2 |
| 4 | 4 | 7 | 3 | 1 | 1 | 2 |
| 4 | 4 | <13 | ... | ... | ... | ... |

**Table SP-3: Extended CDMA Location Measurement Combinations**

As can be seen from the table, a much larger combination of measurements is potentially feasible using the extended data collection capability of the CDMA receivers. In the case of the last row shown, additional combinations are also possible using a similar scheme of allocating the number of CDMA fingers detected at the first or strongest BS, followed by the second strongest base station, then the third strongest base station, etc.

Fig. 29 illustrates the components of the Signal Processing Subsystem 20. The main components consist of the input queue(s) 7, signal classifier/filter 9, digital signaling processor 17, imaging filters 19, output queue(s) 21, router/distributor 23, a signal processor database 26 and a signal processing controller 15.

Input queues 7 are required in order to stage the rapid acceptance of a significant amount of RF signal measurement data, used for either location estimate purposes or to accept autonomous location data. Each location request using fixed base stations may, in one embodiment, contain from 1 to 128 radio frequency measurements from the mobile station, which translates to approximately 61.44 kilobytes of signal measurement data to be collected within 10 seconds and 128 measurements from each of possibly four base stations, or 245.76 kilobytes for all base stations, for a total of approximately 640 signal measurements from the five sources, or 307.2 kilobytes to arrive per mobile station location request in 10 seconds. An input queue storage space is assigned at the moment a location request begins, in order to establish a formatted data structure in persistent store. Depending upon the urgency of the time required to render a location estimate, fewer or more signal measurement samples can be taken and stored in the input queue(s) 7 accordingly.

The signal processing subsystem 20 supports a variety of wireless network signaling measurement capabilities by detecting the capabilities of the mobile and base station through messaging structures provided bt the location application programming interface 14 in Fig. 1. Detection is accomplished in the signal classifier 9 (Fig. 29) by referencing a mobile station database table within the signal processor database 26, which provides, given a mobile station identification number, mobile station revision code, other mobile station charactersitics. Similiarly, a mobile switch center table 31 provides MSC characteristics and identifications to the signal classifier/filter 9. The signal classifier/filter adds additional message header information that further classifies the measurement data which allows the digital signal processor and image filter components to select the proper internal processing subcomponents to perform operations on the signal measurement data, for use by the location estimate modules.

Regarding service control point messages autonomously received from the input queue 7, the signal classifier/filter 9 detemines via a signal processing database 26 query that the message is to be associated with a home base station module. Thus appropriate header information is added to the message, thus enabling the message to pass through the digital signal processor 17 unaffected to the output queu 21, and then to the router/distributor 23. The router/distributor 23 then routes the message to the HBS module 6 shown in Fig. 1. Those skilled in the art will understand that associating location requests from Home Base Station configurations require substantially less data: the mobile identification number and the associated wireline telephone number transmission from the home location register are on the order of less than 32 bytes. Consequentially the home base station message type could be routed without any digital signal processing.

Output queue(s) 21 are required for similar reasons as input queues 7: relatively large amounts of data must be held in a specific format for further location processing by the location estimate modules.

The router and distributor component 23 is responsible to directing specific signal measurement data types and structures to their appropriate modules. For example, the HBS module has no use for digital filtering structures, whereas the TDOA module would not be able to process an HBS response message.

The controller 15 is responsible for staging the movement of data among the signal processing subsystem 20 components input queue 7, digital signal processor 17, router/distributor 23 and the output queue 21, and to initiate signal measurments within the wireless network, in response from an internet 68 location request message in Fig. 1, via the location application programming interface 14.

In addition the controller 15 receives autonomous messages from the MSC, via the location applications programming interface 14 (Fig. 1) or L-API and the input queue 7, whenever a 9-1-1 wireless call is originated. The mobile switch center provides this autonomous notification to the location system as follows: By specifiying the appropriate mobile switch center operations and maintenance commands to surveil calls based on certain digits dialed such as 9-1-1, the location applications programming interface 14 (Fig. 1), in communications with the MSC 12a and 12b in Fig.1, receives an autonomous notification whenever a mobile station user dials 9-1-1. Specifically, a bi-directional authorized communications port is configured, usually at the operations and maintenance subsystem of the MSC 12a and 12b in Fig. 1, or with their associated network element manager system(s), with a data circuit, such as a DS-1, with the location applications programming interface 14 in Fig. 1. Next, the "call trace" capability of the mobile switch center is activated for the respective communications port. The exact implementation of the vendor-specific man-machine or Open Systems Interface (OSI) commands(s) and their associated data structures generally vary among MSC vendors, however the trace function is generally available in various forms, and is required in order to comply with Federal Bureau of

Investigation authorities for wire tap purposes. After the appropriate surveillance commands are established on the MSC, such 9-1-1 call notifications messages containing the mobile station identification number (MIN) and, in phase I E9-1-1 implementations, a pseudo-automatic number identication (a.k.a. pANI) which provides an association with the primary base station in which the 9-1-1 caller is in communicaiton. In cases where the pANI is known from the onset, the signal processing subsystem avoids querying the MSC in question to determine the primary base station identification associated with the 9-1-1 mobile station caller.

After the signal processing controller 15 receives the first message type, the autonomous notification message from the mobile switch center 112 to the location system 42, containing the mobile identification number and optionally the primary base station identification, the controller 15 queries the base station table 13 in the signal processor database 26 to determine the status and availability of any neighboring base stations, including those base stations of other CMRS in the area. The definition of neighboring base stations include not only those within a provisionable "hop" based on the cell design reuse factor, but also includes, in the case of CDMA, results from remaining set information autonomously queried to mobile stations, with results stored in the base station table. Remaining set information indicates that mobile stations can detect other base station (sector) pilot channels which may exceed the "hop" distance, yet are nevertheless candidate base stations (or sectors) for wireless location purposes. Although cellular and digital cell design may vary, "hop" distance is usually one or two cell coverage areas away from the primary base station's cell coverage area.

Having determined a likely set of base stations which may both detect the mobile station's transmitter signal, as well as to determine the set of likely pilot channels (i.e., base stations and their associated physical antenna sectors) detectable by the mobile station in the area surrounding the primary base station (sector), the controller 15 initiates messages to both the mobile station and appropriate base stations (sectors) to perform signal measurements and to return the results of such measurements to the signal processing system regarding the mobile station to be located. This step may be accomplished via several interface means. In a first case the controller 15 utilizes, for a given MSC, predetermined storage information in the MSC table 31 to determine which type of commands, such as man-machine or OSI commands are needed to request such signal measrurements for a given MSC 12a or 12b in Fig. 1. The controller generates the mobile and base station signal measurement commands appropriate for the MSC and passes the commands via the input queue 7 and the locations application programming interface 14 in Fig.1, to the appropriate MSC 12a and 12b, using the authorized communications port mentioned earlier. In a second case the controller 15 communicates directly with base stations as discussed above and shown in Fig. 5, Location Center-base station access, multiple CMRS, in this second case an alternative embodiment is provided to directly extract the wireless location signal measurement data from each base station associated with each of multiple CMRS networks within having to interface directly with the MSC for signal measurement extraction.

Upon receipt of the signal measurements, the signal classifier 9 examines location application programming interface-provided message header information from the source of the location measurement (for example, from a fixed BS 122, a mobile station 140, a distributed antenna system 168 or message location data related to a home base station), provided by the location applications programming interface (L-API) via the input queue 7 and determines whether or not device filters 17 or image filters 19 are needed, and assesses a relative priority in processing, such as an emergency versus a background location task, in terms of grouping like data associated with a given location request. In the case where multiple signal measurement requests are outstanding for various base stations, some of which may be associated with a different CMRS network, and additional signal classifier function includes sorting and associating the appropriate incoming signal measurements together such that the digital signal processor 17 processes related measurements in order to build ensemble data sets. Such ensembles allow for a variety of functions such as averaging, outlier removal over a timeperiod, and related filtering functions, and further prevent association errors from occuring in location estimate processing.

Another function of the signal classifier/low pass filter component 9 is to filter information that is not useable, or information that could introduce noise or the effect of noise in the location estimate modules. Consequently low pass matching filters are used to match the in-common signal processing components to the characteristics of the incoming signals. Low pass filters match: Mobile Station, base station, CMRS and MSC characteristics, as wall as to classify Home Base Station messages.

The signal processing subsystem 20 in Fig. 1 contains a base station database table 13 (Fig. 29) which captures the maximum number of CDMA delay spread fingers for a given base station, containing information structures as shown in table SP-4 below:

| Primary Base Station Identification | Latitude, Longitude, elevation | Pilot Channel Offset | BS Identifier code | Maximum No. of CDMA Fingers |
|---|---|---|---|---|
| DEN-001 | x, y, z | 5 | CODENABC001 | 4 |
| DEN-002 | p, q, r | 25 | CODENABC002 | 4 |
| DEN-003 | s, t, u | 20 | CODENABC003 | 3 |
| DEN-004 | a, b, c | 15 | CODENABC004 | 4 |
| BLD-005 | d, e, f | 45 | COBLDABC005 | 4 |
| | | | | |

**Table SP-4: Base Station Characteristics**

The base station identification code, or CLLI or common language level identification code is useful in identifying or relating a human-labeled name descriptor to the Base Station. Latitude, Longitude and elevation values are used by other subsystems in the location system for calibration and estimation purposes. As base stations and/or receiver characteristics are added, deleted, or changed with respect to the network used for location purposes, this database table must be modified to reflect the current network configuration.

Just as an upgraded base station may detect additional CDMA delay spread signals, newer or modified mobile stations may detect additional pilot channels or CDMA delay spread fingers. Additionally different makes and models of mobile stations may acquire improved receiver sensitivities, suggesting a greater coverage capability. The table below establishes the relationships among various mobile station equipment suppliers and certain technical data relevant to this location invention.

Although not strictly necessary, The MIN can be populated in this table from the PCS Service Provider's Customer Care system during subscriber activation and fulfillment, and could be changed at deactivation, or anytime the end-user changes mobile stations. Alternatively, since the MIN, manufacturer, model number, and software revision level information is available during a telephone call, this information could extracted during the call, and the remaining fields populated dynamically, based on manufacturer's' specifications information previously stored in the signal processing subsystem 20. Default values are used in cases where the MIN is not found, or where certain information must be estimated.

| Mobile Station Identification (MIN) | Manufact-urer | Model No. | Allowed S/W Revision Levels | Maximum No. of CDMA Fingers | Maxim um No. of Pilots Detecta ble | Transmit Power Class (Max) | Rec. Thermal Noise Floor (dBm) |
|---|---|---|---|---|---|---|---|
| 3034561234567 | Sony | 5 | R1.0 | 3 | 3 | 2 | -114 |
| 3034561234568 | Qualcomm | 25 | R2.01 | 4 | 4 | 4 | -115 |
| 3034561234569 | Panasonic | 20 | R1.1 | 3 | 3 | 5 | -113 |
| 3034561234570 | Fujutshu | 15 | R2.5 | 4 | 4 | 0 | -116 |
| 3034561234571 | Sony | 45 | R1.1 | 3 | 3 | 7 | -115 |
| Default | Default | Default | R1.0 | 3 | 3 | 3 | -112 |

**Table SP-5: Mobile Station Characteristics Table**

A low pass mobile station filter, contained within the signal classifier/low pass filter 9 of the signal processing subsystem 20, uses the above table data to perform the following functions: 1) act as a low pass filter to adjust the nominal assumptions related to the maximum number of CDMA fingers, pilots detectable; and 2) to determine the transmit power class and the receiver thermal noise floor. Given the detected reverse path signal strength, the required value of $SRSS_{MS,}$ a corrected indication of the effective path loss in the reverse direction (mobile station to BS), can be calculated based on the SP-5 table data contained within the mobile station table 11, in the signal processing database 26.

The effects of the maximum Number of CDMA fingers allowed and the maximum number of pilot channels allowed essentially form a low pass filter effect, wherein the least common denominator of characteristics are used to filter the incoming RF signal measurements such that a one for one matching occurs. The effect of the Transmit Power Class and Receiver Thermal Noise floor values is to normalize the characteristics of the incoming RF signals with respect to those RF signals used.

Fig. 4, Location Provisioning from Multiple CMRSs, illustrates a system architecture to enable the customer care systems belonging to different CMRSs, either on an autonomous or periodic basis, to update a provisionable signal processing database 26, containing the mobile station characteristics, in communication with the signal classifier/filter 9, input queue 7, and the location applications programming interface for customer casre systems (L-API-CCS) 139. The signal classifier/filter 20 is in communication with both the input queue 7 and the signal processing database 26. In the early stage of a location request the signal processing subsystem 142 in Fig. 4, will receive the initiating location request from either an autonomous 9-1-1 notification message from a given MSC, or from a location application (for example, see Fig. 36), for which mobile station characteristics about the target mobile station 140 (Fig. 2) is required. Referring to Fig. 29, a query is made from the signal processing controller 15 to the signal processning database 26, specifically the mobile station table 11, to determine if the mobile station characteristics associated with the MIN to be located is available in table 11. if the data exists then there is no need for the controller 15 to query the wireless network in order to determine the mobile station characteristics, thus avoiding additional real-time processing which would otherwise be required across the air interface, in order to determine the mobile station MIN characteristics. The resulting mobile station information my be provided either via the signal processing database 26 or alternatively a query may be performed directly from the signal processing subsystem 20 to the MSC in order to determine the mobile station characteristics.

A location application programming interface, L-API-CCS 139 to the appropriate CMRS customer care system provides the mechanism to populate and update the mobile station table 11 within the database 26. The L-API-CCS 139 contains its own set of separate input and output queues or similar implementations and security controls to ensure that provisioning data is not sent to the incorrect CMRS. The interface 1155a to the customer care system for CMRS-A 1150a provides an autonomous or periodic notification and response application layer protocol type, consisting of add, delete, change and verify message functions in order to update the mobile station table 11 within the signal processing database 26, via the controller 15. A similar interface 1155b is used to enable provisioning updates to be received from CMRS-B customer care system 1150b.

Although the L-API-CCS application message set may be any protocol type which supports the autonomous notification message with positive acknowledgment type, the T1M1.5 group within the American National Standards Institute has defined a good starting point in which the L-API-CCS could be implemented, using the robust OSI TMN X-interface at the service management layer. The object model defined in Standards proposal number T1M1.5/96-22R9, *Operations Administration, Maintenance, and Provisioning (OAM&P) - Model for Interface Across Jurisdictional Boundaries to Support Electronic Access Service Ordering: Inquiry Function*, can be extended to support the L-API-CCS information elements as required and further discussed below. Other choices in which the L-API-CCS application message set may be implemented include ASCII, binary, or any encrypted message set encoding using the Internet protocols, such as TCP/IP, simple network management protocol, http, https, and email protocols.

Referring to the digital signal processor (DSP) 17, in communication with the signal classifier/LP filter 9, the DSP 17 provides a time series expansion method to convert non-HBS data from a format of an signal measure data ensemble of time-series based radio frequency data measurements, collected as discrete time-slice samples, to a three dimensional matrix location data value image representation. Other techniques further filter the resultant image in order to furnish a less noisy training and actual data sample to the location estimate modules.

Referring now to digital signal and image filter processing, by way of example, a forward-path CDMA mobile station delay spread RF measurement sample is illustrated in Fig. 22, for the mobile station reception of one sample of transmission signal related to BS-1, located at 16th and Stout Streets. In this sample three fingers or groups of RF energy (relative signal strength is indicated along the vertical axis) were detected. A first CDMA finger was found at a delay of about 3.4 microseconds, and relative signal strength of about -80 dBm. A second finger was found at a delay of about 5 microseconds, and peak strength of about -55 dBm, followed by a third finger at 6.5 microseconds and a strength of about -92 dBm. Two other base stations were detected, BS-5 and BS-2, along with their respective three CDMA delay spread fingers.

Refer now to the left image shown in Fig. 26: Delay Spread Profile Image. After 128 samples of data are collected of the delay spread-relative signal strength RF data measurement sample: mobile station RX for BS-1 and grouped into a Quantization matrix, where rows constitute relative signal strength intervals and columns define delay intervals. As each measurement row, column pair (which could be represented as a complex number or Cartesian point pair) is added to their respective values to generate a Z direction of frequency of recurring measurement value pairs or a density recurrence function. By next applying a grid function to each x, y, and z value, a three-dimensional surface grid is generated, which represents a location data value or unique print of that 128-sample measurement. Fig. 28 illustrates the result of image generation when a number of data samples, or an ensemble of signal strength, delay paris of values are added within a given bin area or matrix, to thus create a type of three-dimensional image, representing a particular RF signaling behavior at a given location.

Refer now to the right image shown in Fig. 26. In the general case where a mobile station is located in an environment with varied clutter patterns, such as terrain undulations, unique man-made structure geometries (thus creating varied multipath signal behaviors), such as a city or suburb, although the first CDMA delay spread finger may be the same value for a fixed distance between the mobile station and BS antennas, as the mobile station moves across such an arc, different finger-data are measured. In the right image for the defined BS antenna sector, location classes, or squares numbered one through seven, are shown across a particular range of line of position (LOP).

A traditional TOA/TDOA ranging method between a given BS and mobile station only provides a range along the arc, thus introducing ambiguity error. However a unique three dimensional image can be used in this method to specifically identify, with recurring probability, a particular unique location class along the same Line Of Position, as long as the multipath is unique by position but generally repeatable, thus establishing a method of not only ranging, but also of complete latitude, longitude location estimation in a Cartesian space. In other words, the unique shape of the "mountain image" enables a correspondence to a given unique location class along a line of position, thereby eliminating traditional ambiguity error.

Although man-made external sources of interference, Rayleigh fades, adjacent and co-channel interference, and variable clutter, such as moving traffic introduce unpredictability (thus no "mountain image" would ever be exactly alike), three basic types of filtering methods can be used to reduce matching/comparison error from a training case to a location request case: 1.) select only the strongest signals from the forward path (BS to mobile station) and reverse path (mobile station to BS), 2.) Convolute the forward path 128 sample image with the reverse path 128 sample image, and 3.) process all image samples through various digital image filters to discard noise components.

The strongest signal technique has been discussed previously in the data filter section. Fig. 27: Convolution of Forward and Reverse Images, illustrates one method that essentially nulls noise completely, even if strong and recurring, as long as that same noise characteristic does not occur in the opposite path.

The third technique of processing CDMA delay spread profile images through various digital image filters, provides a resultant "image enhancement" in the sense of providing a more stable pattern recognition paradigm to the neural net location estimate model. For example, image histogram equalization can be used, as illustrated in Fig. 30 (before equalization) and 31 (after equalization) to rearrange the images' intensity values, or density recurrence values, so that the image's cumulative histogram is approximately linear.

Other methods which can be used to compensate for a concentrated histogram include: 1) Input Cropping, 2) Output Cropping and 3) Gamma Correction. Equalization and input cropping can provide particularly striking benefits to a CDMA delay spread profile image. Figs 32 and 33 illustrate the three dimensional grid images of the before and after input cropping filter example. As shown in Fig. 33, input cropping removes a large percentage of random signal characteristics that are non-recurring.

Other filters and/or filter combinations can be used to help distinguish between stationary and variable clutter affecting multipath signals. For example, it is desirable to reject multipath fingers associated with variable clutter, since over a period of a few minutes such fingers would not likely recur. Further filtering can be used to remove recurring (at least during the sample period), and possibly strong but narrow "pencils" of RF energy. A narrow pencil image component could be represented by a near perfect reflective surface, such as a nearby metal panel truck stopped at a traffic light.

On the other hand, stationary clutter objects, such as concrete and glass building surfaces, adsorb some radiation before continuing with a reflected ray at some delay. Such stationary clutter-affected CDMA fingers are more likely to pass a 4X4 neighbor Median filter as well as a 40 to 50 percent Input Crop filter, and are thus more suited to neural net pattern recognition. Fig. 33 illustrate five "pencils" of CDMA finger energy that passed a simple 50 percent Input Crop filter. However, as shown in Fig. 34 when subjected to a 4X4 neighbor Median filter and 40 percent clipping, all five pencil-shaped fingers have been deleted. Fig. 35 illustrates the further simplified result of a 50 percent cropping and 4X4 neighbor median filtering. Other filtering methods include custom linear filtering, adaptive (Weiner) filtering, and custom nonlinear filtering.

The DSP 17 may provide data emsemble results, such as extracting the shortest time delay with a detectable relative signal strength, to the router/distributor 23, or alternatively results may be processed via one or more image filters 19, with subsequent transmission to the router/distributor 23. The router/distributor 23 examines the processed message data from the DSP 17 and stores routing and distribution information in the message header. The router/distributor 23 then forwards the data messages to the output queue 21, for subsequent queuing then transmission to the appropriate location estimators DA module 10, TOA/TDOA module 8 or the HBS module 6, in Fig. 1.

## HOME BASE STATION MODULE

Upon receiving a message from the Data Capture Gateway or the signal processing subsystem 20, the HBS location estimate model examines a Home Base Station Table which defines relationships among a wireless MIN, and wireline telephone number, characteristics of the HBSD, and the possibility to use various signal types in order to further define the location within the address area of the fixed location HBSD. The following table, populated by the commercial mobile radio service provider at HBSD installation time, is used by the HBS model to determine location whenever the mobile station 140 is located within communication range of the HBSD:

| Wireline MIN | Wireless MIN | HBSD Model | HBSD location Latitude, Longitude | Fixed HBSD Location | CDMA Strength/Delay Measurements ? |
|---|---|---|---|---|---|
| 3035561234 | 3035661299 | Sony Qx-9000, Rev. 1.1 | 52.619488 N, 112.4197601 W | 727 Magnolia Drive, Boulder, CO | No |
| 3035561236 | 3035661200 | Panasonic PF-130, Rev. 5.0 | 52.645488 N, 112.4197601 W | 1401 Digit Drive, Boulder, CO | Yes |
| 3035561236 | 3035661240 | Panasonic PF-130, Rev. 3.4 | 52.779488 N, 112.4197601 W | 1698 Folsom St., Boulder, CO. | No |
| 3035561284 | 3035661205 | Panasonic PF-180, Rev. 5.0 | 51.619488 N, 111.9197601 W | 990 Nutcracker Dr., Niwot, CO. | NO |
| 3035561224 | 3035661266 | Panasonic PF-5000, Rev. 1.0 | 52.619558 N, 112.4197601 W | 5606 Bismark Circle, Denver, CO | Yes |
| ... | ... | ... | | ... | ... |

**Table HBS-1: HBSD Characteristics**

In the event RF signals are available for telemetry from the HBSD to the location system, such information may be solicited from the location system to the HBSD, in the form of a request/response message scheme, using for example, a data-under-voice technique. In such cases the SSP provides a data connection with the location system 42 via the PSTN. The home base station may interact with the mobile station in the same manner as a cordless telephone transceiver interacts with a cordless telephone, when the mobile station is within an acceptable range.

The HBS module 6 in Fig. 1 outputs the Latitude and Longitude location estiamtes to either the PSTN 24 or to the Internet 68, dependending upon the source of the originating location request.

## DISTRIBUTED ANTENNA MODULE

Upon receipt of one or more data ensemble messages from the signal processing subsystem 20 in Fig. 1, the distributed antenna (DA) module 10 queries a previously populated distributed antenna database to determine the locations of distributed antennas associated with the measured DA antenna "pilot delays" so that the detected signal measurement delay signal values received from the mobile station receivers and base station receivers can be input to the TOA/TDOA module. The TOA/TDOA module then utilizes the radius-radius method, or time difference method, in order to provide location estimates within the building or area containing the distributed antennas.

## DAISEY CHAINING BASE STATIONS

As a practical matter it may be necessary in some network conditions to add base stations in areas to permit improved estimates to be achieved in wireless location. An aspect in this invention includes daisey chaining communication circuits or transport facilities between or among base stations, in order to simplify the installation and operation of such base stations. Base stations normally communicate with the mobile switch center using T-carrier transport facilities, in order to carry voice and data bearer traffic, and to transport bi-directional control signals. However for various economic or other reasons it may not be justifiable to install such transport facilities. At the base station, by essentially originating a plurality of mobile telephone calls using the data communications option, and terminating such calls at the mobile switch center appropriately, the outputs of the base station transport multiplex circuits are re-directed into the data communication circuits normally intended for use by mobile stations in establishing a data circuit communication call to the network. Circuits at the mobile switch center used to terminate these data calls, redirect the communication to those circuits normally used to terminate the T-carrier facilities from the base stations. In this manner, existing wireless channels can be used to provide transport via this daisy-chaining method between certain base stations and the mobile switch center, thus simplifying connectivity in cases where the installation of transport facilities would either be impossible or impractical.

## DISTANCE FIRST ORDER MODULE (TOA/TDOA)

Particular distinctions over the current state of the art include utilizing essentially the native electronics, antennas and standards, and opposed to overlay solutions, supervisor functions which control a hybrid set of techniques, including Time Of Arrival (TOA), Time Difference of Arrival (TDOA) in both the forward and reverse paths, pilot signal strengths, power control, mobile stations (mobile station) state conditions, stochastic features of environmental clutter, multipath detection and mitigation, and robustness, supporting a variety of conditions including degraded/faulty equipment, distributed and SMART antennas, various registration modes, and various call processing conditions such as soft, hard and idle hand-off conditions, location during the idle state, traffic-bearing states, and location during cases of severe multipath, such as that experienced in urban canyon environments, as well as location in suburban and rural cases.

Since each base station is required to emit a constant signal-strength pilot pseudo-noise (PN) sequence on the forward link channel identified uniquely in a network system by a pilot sequence offset and frequency assignment, it is possible to use the pilot channels of active, candidate, neighboring and remaining sets of pilots, associated with neighboring base stations, stored in the mobile station, for TOA and TDOA measurements performed by the mobile station.

Based on the arrival time measurement estimates and the speed of propagation, ranges or range differences between the base stations and the mobile station can be calculated. TOA and/or TDOA measurements can then be input to either the radius-

radius multilateration or the time difference multilateration algorithms.

By utilizing the known base station positions, location of the mobile station can be determined. Since measurements and base station positions can be sent either to the network or the mobile station, location can be determined in either entity.

Since not all measurements can provide accurate location results at all times and conditions, a variety of supervisory logic processes can be invoked to resolve or litigate the problem area.

As those familiar with the EIA/TIA IS-95 and T1P1/JTC CDMA standards specifications know, mobile station call processing consists of four states:

1. *Initialization State* - where the mobile station selects and acquires a system, a network, and timing information. This state consists of four substates: *System Determination, Pilot Channel Acquisition, Sync Channel Acquisition*, and *Timing Change Substate*;
2. *Idle State* - where the mobile station monitors messages on the Paging Channel, and supports procedures such as Message Acknowledgment, nine modes of Registration, Idle Hand-off, Pilot Search, and response to Overhead Information, such as System and Access Parameters (which include BS Latitude and Longitude), mobile station Message Transmission Operation (i.e., Data Burst) and Neighboring List messages;
3. *System Access State* - where the mobile station sends messages to the base station on the Access Channel. This state consists of six substates: Update Overhead, Origination Attempt, Page Response, mobile station Order/Message Response, Registration Access; Message Transmission Operation/Data Burst);
4. *Mobile station Control on the Traffic Channel State* - where the mobile station communicates with the primary base station using the forward and Reverse Traffic Channels. This state consists of five substates: *TC initialization, Waiting for Order, Waiting for mobile station Answer, Conversation* (which includes hand-off procedures and earliest arriving usable multipath components of pilots), and *Release*.

At power-up an IS-95 or T1P1 PCS CDMA compliant mobile station enters *Initialization State*, as described in IS-95, section 6.6.1. During the *System Determination* substate, the mobile station refers to its internal memory to acquire preferences for system carrier (A or B), or the preferred carrier at 1.8-2.0 GHz, and for other types of service, including advanced mobile phone service, or AMPS, as well as narrow band advanced mobile phone service, or NAMPS.

A CDMA-preferred mobile station then transfers to the *Pilot Acquisition* Substate. The mobile station tunes to the CDMA Channel number equal to $CDMACH_S$ then sets its Walsh code (always W0) for the Pilot channel where it begins searching for pilot energy, in terms of energy per bit, per spectral density.

Once a sufficiently strong (as defined by the T_ADD threshold parameter) pilot channel has been identified within $T_{20m}$ seconds, the mobile station enters the *Sync Channel Acquisition* Substate, where the mobile station receives a *Sync channel Message* that includes, among other information, system time and the unique PN offset index for that particular BS. In the *Timing Change* substate, the mobile station adjusts its internal timing to match the BS's CDMA system time. At the completion of the

Timing Change substate, the mobile station is completely synchronized to the CDMA system's BS time.

After satisfactory synchronization the mobile station then enters the stable *Idle* State, where the paging channel begins to be monitored.

At this point at least two alternatives are possible:

1. Perform Location determination without consumption of user-perceived air time via the introduction of a new call processing state, or
2. Perform Location determination via the traffic channel (requires air time)

In cases where Distributed Antennas (DAs), and/or Home Base Stations (HBS) are used, each location of these devices can be sent to the mobile station. There are at least three format-types possible in conveying this type of location information in the GeoLocation Message. First, A unique identifier can be assigned to each DA/HBS, such as a fully distinguished name. An example of location information could be: Within the USA, State of Colorado, city of Denver, with Service Provider xyz, BS ID 129, Distributed Antenna number 8. Or more compactly, the location string is structured as, "USA.CO.DEN.xyz.129.DA8". Secondly, an easy-to-understand human style data message can be sent, such as, "You are near the 30th floor of the Sears Tower building". Third, data values for Latitude, Longitude, and possibly altitude and accuracy could be sent from the BS or Location Center to the mobile station/LU ("LU" denoting . In order to be most easily useful to and end-user, in the first and third cases, a database would be needed within the mobile station or a Personal Digital Assistant device, which performs a translation of numerical data into a form useful for human understanding.

The mobile station thus maintains a list of location pilot offsets, where the list is ranked based on a weighted combination of received signal energy and BS location. The mobile station selects the best candidate BSs for location estimate purposes, which may be slightly different from the Active, candidate and remaining lists.

Additionally the mobile station may send a Data_Burst message back to the BS or Location Center, informing that no other Pilot Channels were detected. This "negative" Venn diagram information may be useful with various heuristics for location estimate deduction, for example, to note where the mobile station is not located.

It is the difference of system time values (as opposed to their absolute values) that is important. Note that for purposes of location, any communication back to a BS 122 would require re-synchronizing onto that BS's system time. Although not specified in either IS-95 or T1P1/JTC's PCS CDMA standards, most mobile station manufacturers build correlators with resolutions of approximately 1/8 PN chip, which is about 125 nS. A location equipped mobile station will provide +/- 125 nS. accuracy, which is about +/- 125 feet.

The mobile station or location entity can process the arrival time estimates in at least two ways. first the mobile station may difference the measurements (preferred) to form time-difference-of-arrivals (TDOA); or second, the mobile station may determine absolute time-of-arrival (TOA) by solving for the clock bias between the mobile station and other CDMA system time reports. TOA requires very well calibrated BS system clocks among each other.

The following procedure illustrates significant capabilities hidden in the CDMA standards, which provide a substantial enabling base with which to provide the measurements and data for this inventions' location methods.

First the BS sends the *Neighbor List Update Message*, containing a complete list of the neighboring pilot PN sequence offset indices (i.e., via the NGHBR_PN field) associated with candidate BSs in the area, with which the mobile station could possibly scan for detecting usable earliest arriving neighboring useable BS multipath components. This list should typically be a complete list, as opposed to the presumed candidate subset. If the mobile station is not already in the Traffic/Conversation State, it could invoke this state by calling a dialable telephone number in the network, e.g., a designed "Quiet Line" This approach also allows a billing record to be generated according to routine wireless telephony practice. If the network is to determine location, then the network pages the mobile station 140, connecting the mobile station to a Quiet Line/Voice message upon mobile station answer. Note that it may be desirable to suppress the mobile station ringer sounding for certain location applications. Other methods may also be possible.

During installation, each BS 122 in a particular area is provisioned with the locations of all possible neighboring BSs in its area. The BSs 122 use this information to populate a list of all Latitudes and Longitudes which can be sent to the LUs, using the *Neighbor List Update message*. Second, assuming that the mobile station does not currently have this data or if unknown, then the BS shall send a series of *Mobile Station Registered Messages*, each message containing the latitude and Longitude values (i.e., the BASE_LAT and BASE_LONG fields) associated with a neighboring BS pilot PN offset sent with the first message. Note that the constants $N_{6m}$, Supported Traffic Channel Candidate Active Set size, normally set to 6, and $N_{7m}$, Supported Traffic Channel Candidate Set size, normally set to 5, and $N_{8m}$, the Minimum Supported Neighbor Set size, normally set to 20, should be sufficient for most location purposes, however these constants could be changed if the need arises.

Third, the BS saves the current T_ADD and T_DROP values in the BS memory, associated with the In-Traffic LU, and sends the *In-Traffic System Parameters* Message, which includes reduced T_ADD and T_DROP parameter values, useable for location purposes. The value for T_ADD would typically be set to a value near the lower end of the IS-98 specification, possibly below the 80 dB dynamic range requirement, close to (but not including) the thermal noise power level of the LU receiver. Note that if the LU is using restricted battery, e.g., a portable, then the time for keeping T_ADD and T_DROP at a low value for location estimates purposes, should be kept short to conserve adverse consequences, such as increased current drain and noise.

Reduced T_ADD and T_DROP values sent to the mobile station will cause the LU to scan all conceivable neighboring BS pilots provided to it by the BS, and to measure the strengths of each received pilot, and to determine the pilot arrival time for each pilot offset. Note that the signal strengths now measured may not be sufficient for carrying traffic, but may be sufficient for location purposes.

Assuming the network is to determine location, then the mobile station reports the arrival time, PILOT_ARRIVAL, for each pilot reported to the base station. According to the standard the arrival time is measured relative to the mobile station's time reference (which was previously determined from the active BS), in units of PN chips (1/2288) microseconds, or about 814 nanoseconds, as follows:

$$\text{PILOT\_PN-PHASE} = (\text{PILOT\_ARRIVAL} + (64 \text{ X PILOT\_PN})) \bmod 2^{15},$$

where PILOT_PN is the PN sequence offset index of the pilot associated with the BS pilot indices in the neighbor list.

In order to achieve location accuracy estimates on the order of a few hundred feet (or nanoseconds) a higher resolution than 1 PN chip is required. Although not specified directly in IS-95, most mobile manufacturers use correlators with resolutions of approximately 1/8 PN chip, or about 102 nS (suggesting that if no other systemic errors are present, about 102 feet of error is expected). Note that the search window size SRCH_WIN_$A_r$ for each pilot may need to be increased if there are substantial delays experienced from the environment. It is desirable for the mobile station to report the second and third arrival time (or the second and third fingers), and their relative signal strengths, corresponding to each detectable Pilot Channel.

If more than one PILOT_ARRIVAL is available then a basic TDOA multilateration algorithm may be invoked, at either the LU, or the network. In the network case, the active BS 122 must send a Pilot Request Order for Pilot Measurement Request Order (ORDER code 010001), which causes the mobile station 140 to forward its measurements to the BS (and consequently the network, as appropriate).

At this point a minimally sufficient number of measurements are available to perform a location estimate. Thus the BS should restore the original T_ADD and T_DROP values (previously saved in the BS memory) to the mobile station, via the *In-Traffic System Parameters* Message.

Additional information may be desirable, such as the active BS' TOA measurement, as well as associated BS measurements of the mobile station's TOA to their BS location. This added information may be sent to the mobile station if the mobile station is to perform location, via the *Data Burst Message* on the *Forward Traffic Channel*. Since 26 combinations of data burst types have been reserved for future use in the standard, dedication of several combinations could be used to telemeter location-related data. In cases where duplicate ranging or other information is available, various supervisor techniques mentioned elsewhere in this document, could be used to refine the location estimate.

Once the location estimate has been performed, any number of means could be used to provide the results to the end user.

The IS-95 and J-STD-008 CDMA specifications require that BSs should be synchronized to within +/- 3 microseconds of CDMA system time and shall be synchronized to within +/- 10 microseconds. This invention disclosure method assumes the cost of GPS receivers is relatively small, thus time calibration at a more precise calibration level at each location BS is recommended to be used by using the very accurate GPS time parameters. Preferably the absolute error deviation among surrounding or neighboring base stations should be less than 800 nanoseconds, however in most cases this should not be a fixed requirement, but rather a preference. In cases where absolute BS timing is prohibitively expensive, then the "Forced Hand-off" method discussed below can be used to overcome the preferred, or strict absolute BS timing requirements.

Three methods have been currently identified. Some of these techniques apply to other air interface types as well.

1. Use the first finger at BS (Absolute Ranging), and if detecteable, invoke a "Forced Hand-off" between the mobile station and a

neighboring BS, for a time sufficient to complete signal measurements between a mobile station transmitter and a BS receiver, and if possible, between a BS transmitter and a mobile station receiver, which gives access to as many BS's as can be detected either by the mobile station receiver or the surrounding BS receivers.

2. Use the first finger at mobile station (Differential Ranging) to obtain differential time readings of pilot channel from mobile station

3. Use the Pilot Power Level Measurements and Ground Clutter (Stochastic information)

Now in the general case where three or more BSs can either determine TDOA and/or the mobile station can telemeter such data to the location entity within the network, repeat this method for $BS_2$ and $BS_3$, and $BS_3$ and $BS_1$, in order to determine the remaining curves, thus yielding location within a 2D space. In the case of 3D geometry (such as a multi-story building with multi-floor pico BS cells), the process must be repeated a fourth time in order to determine altitude.

MATLAB MathWorks code to implement the above algorithms follows:

```
clear;hold off;
j = sqrt(-1);
step_size = 0.03;

# Set up BS variables
 theta = pi/3*ones(3,1);
 D = 10*ones(3,1);
 z(1) = 0;
 z(2) = D(1);
 z(3) = D(3)*exp(-j*theta(1));

# Define the distance parameters
 d = [0 6.4 -6.8]';
 location1 = [];
 location2 = [];
 location3 = [];

# Iterate and solve for the location with respect to the first BS (at (0,0) )
 t2 = -pi:0.05:0.05;
 for t1 = -pi/3:0.05:0.05,
  t1 = t1+0.001;
  r1 = 1./(exp(j*t1)-exp(j*t2)).*(D(1)-d(1)*exp(j*t2));
  r2 = 1./(exp(j*t1)-exp(j*t2)).*(D(1)-d(1)*exp(j*t1));
```

```
  temp = arg(r1);
  index = find(abs(temp) == min(abs(temp)));
  location1 = [location1;r1(index)*exp(j*t1)];
end;
for t1 = -pi/3:0.05:0.05
  t1 = t1+0.001;
  r1 = 1./(exp(j*t1)-exp(j*t2)).*(D(2)-d(2)*exp(j*t2));
  r2 = 1./(exp(j*t1)-exp(j*t2)).*(D(2)-d(2)*exp(j*t1));
  temp = arg(r1);
  index = find(abs(temp) == min(abs(temp)));
  location2 = [location2;r1(index)*exp(j*t1)];
end;
for t1 = -pi/3:0.05:0.05
  t1 = t1+0.001;
  r1 = 1./(exp(j*t1)-exp(j*t2)).*(D(1)-d(3)*exp(j*t2));
  r2 = 1./(exp(j*t1)-exp(j*t2)).*(D(1)-d(3)*exp(j*t1));
  temp = arg(r1);
  index = find(abs(temp) == min(abs(temp)));
  location3 = [location3;r1(index)*exp(j*t1)];
end;
location2 = location2*exp(j*arg(z(3)-z(2))) + z(2);
location3 = location3*exp(j*arg(z(1)-z(3))) + z(3);
set yrange [-10:1];
set xrange [-1:11];
plot([z;z(1)])
hold on
plot(location1)
plot(location2)
plot(location3)
```

## WIRELESS LOCATION DATA COLLECTION

It is worthwhile to discuss techniques for both obtaining the initial collection of verified location data, as well as how additional location data can be obtained for updating the data in this data base in a straightforward cost-effective manner.

Regarding both the obtaining of the initial collection of verified location data as well as gathering data updates, it is believed that some of this data can be obtained from the initial and continued engineering of the base station infrastructure by the wireless telephony service provider(s) in the radio coverage area. Additional verified location data can be obtained by trained technicians driving and/or walking certain areas and periodically, at each of a plurality of locations: (a) determining a location estimate (using, for example, GPS if possible and/or offsets from GPS readings); and (b) using an mobile station 140 at the location to generate location data communication with the wireless base station infrastructure.

Alternatively, it is a novel aspect of the present invention that a straightforward method and system for gathering verified location data has been discovered, wherein a conventional mobile station 140 can be used without any additional electronics or circuit modifications. One embodiment of this method and system utilizes the personnel of businesses that travel predetermined routes through the radio coverage area (e.g., a delivery and/or pickup service) to generate such data using a conventional mobile station 140 while traversing their routes through the radio coverage area. One example of such personnel is the postal workers, and in particular, the mail carriers having predetermined (likely repetitive) routes for mail pickup and/or delivery at predetermined sites (denoted hereinafter as "mail pickup/delivery sites" or simply "mail sites"). By having such mail carriers each carry a conventional mobile station 140 and periodically generate location data communication with the wireless base station infrastructure at mail sites along their routes, additional verified location data can be added to the Location Data Base 1129 cost effectively.

To describe how this can be performed, a brief description of further features available in a typical mobile station 140 is needed. At least some modules of mobile station 140 have the following capabilities:

(27.2.1) a unique mobile station 140 identification number; in fact, every mobile station 140 must have such a number (its telephone number);

(27.2.2) the mobile station 140 has a display and a display memory for presenting stored data records having telephone numbers and related data to a user. Further, some portion of each data record is annotation and some portion is able to be transmitted to the wireless base station network. In particular, the mobile station 140 is able to store and recall data records of sufficient size such that each data record may include the following information for a corresponding mail pickup/delivery site along a mail route: (a) an address or other textual description data (e.g., an English-like description) of the mail pickup/delivery site; (b) a predetermined telephone number; and (c) a numerical code (denoted the "site code" hereinafter) associated with the mail pickup/delivery site, wherein the site code is at least unique within a set of site codes corresponding to the mail sites on the mail route. In one embodiment, the memory may store 99 or more such data records, and the display is scrollable through the data records;

(27.2.3) the mobile station 140 can have its display memory updated from either an RS232 port residing on the mobile station, or from an over-the-air activation capability of the wireless network;

(27.2.4) the mobile station 140 has a pause feature, wherein a telephone number can be dialed, and after some predetermined number of seconds, additional predetermined data can be transmitted either through additional explicit user request (e.g., a "hard pause"), or automatically (e.g., a "soft pause"). Moreover, the additional predetermined data can reside in the display memory.

Assuming these features, the following steps can be performed for acquiring additional verified location data:

(27.3.1) For (at least some of the) postal carriers having predetermined routes of addresses or locations visited, the postal carriers are each provided with an mobile station 140 having the capabilities described in (27.2.1) through (27.2.4) above, wherein the memory in each provided mobile station has a corresponding list of data records for the addresses visited on the route of the postal carrier having the mobile station. Moreover, each such list has the data records in the same sequence as the postal carrier visits the corresponding mail sites, and each data record includes the information as in (27.2.2) for a corresponding mail site the postal carrier visits on his/her mail route. More precisely, each of the data records has: (a) a description of the address or location of its corresponding mail pickup/delivery site, (b) a telephone number for dialing a data collection system for the location center 142 (or, alternatively, a reference to a memory area in the mobile station having this telephone number since it is likely to be the same number for most data records), and (c) a site code for the mail pickup/delivery site that is to be transmitted after a predetermined soft pause time-out. Note that the corresponding list of data records for a particular postal route may be downloaded from, for example, a computer at a post office (via the RS232 port of the mobile station 140), or alternatively, the list may be provided to the mobile station 140 by an over-the-air activation. Further, there are various embodiments of over-the-air activation that may be utilized by the present invention. In one embodiment, the postal carrier dials a particular telephone number associated with data collection system and identifies both him/herself by his/her personal identification number (PIN), and the postal route (via a route identifying code). Subsequently, the mail pickup and delivery sites along the identified route are downloaded into the memory of the mobile station 140 via wireless signals to the mobile station 140. However, additional over-the-air techniques are also within the scope of the present invention such as:

(a) If the postal carrier's route is already associated with the carrier's PIN for over-the-air activation, then the carrier may only need to enter his/her PIN.

(b) If the mobile station 140 is already associated with a particular route, then the carrier may only need to activate the mobile station 140, or alternatively, enter his/her PIN for obtaining an over-the-air download of the route.

(c) Regardless of how the initial download of mail sites is provided to the mobile station 140, it is also an aspect of the present invention that if there are more mail sites on a route than there is sufficient memory to store corresponding data records in the mobile station, then the data records may be downloaded in successive segments. For example, if there are 150 mail sites on a particular route and storage for only 99 data records in the mobile station, then in one embodiment, a first segment of 98 data records for the first 98 mail pickup/delivery sites on the route are downloaded together with a $99^{th}$ data record for transmitting an encoding requesting a download of the next 52 data records for the remaining mail sites. (Alternatively, the data collection system may monitor mobile station 140 requests and automatically detect the last location capture request of a downloaded segment, and subsequently automatically download the next segment of mail site data records). Accordingly, when the data records of the first segment have been utilized, a second segment may be downloaded into the mobile station 140.

Moreover, at the end of the last segment, the data collection system may cause the first segment for the route to be automatically downloaded into the mobile station 140 in preparation for the next traversal of the route.

(27.3.2) Given that a download into the mobile station 140 of (at least a portion of) the data for a postal route has occurred , the postal carrier traversing the route then iteratively scrolls to the next data record on the list stored in the mobile station as he/she visits each corresponding mail pickup/delivery site, and activates the corresponding data record. That is, the following steps are performed at each mail pickup/delivery site:

(a) As the postal carrier arrives at each mail pickup/delivery site, he or she checks the scrollable mobile station 140 display to assure that the address or location of the mail pickup/delivery site is described by the data record in the portion of the mobile station display for activating associated data record instructions.

(b) The postal carrier then merely presses a button (typically a "send" button) on the mobile station 140 for concurrently dialing the telephone number of the data collection system, and initiating the timer for the soft pause (in the mobile station 140) associated with the site code for the mail pickup/delivery site currently being visited.

(c) Given that the soft pause is of sufficient length to allow for the data collection system call to be setup, the mobile station 140 then transmits the site code for the present mail pickup/delivery site.

(d) Upon receiving the telephone number of the mobile station 140 (via automatic number identification (AIN)), and the site code, the data collection system then performs the following steps:

(d1) A retrieval of an identifier identifying the route (route id). Note this may be accomplished by using the telephone number of the mobile station. That is, when the data collection system first detects that the mobile station 140 is to be used on a particular route, the telephone number of the mobile station and the route id may be associated in a data base so that the route id can be retrieved using the telephone number of the mobile station..

(d2) A retrieval of a iocation representation (e.g., latitude, longitude, and possibly height) of the mail pickup/delivery site identified by the combination of the route id and the site code is performed by accessing a data base having, for each mail site, the following associated data items: the route id for the mail site, the site code, the mail site address (or location description), and the mail site location representation (e.g., latitude, longitude, possibly height).

(d3) A request to the location center 142 is issued indicating that the location data for the mobile station 140 (resulting from, e.g., the call being maintained between the mobile station and the data collection system) is to be retrieved from the wireless network, temporarily saved, and a location estimate for the mobile station is to be performed. Accordingly, the data collection system request to the location center 142 the following:

(i) the telephone number of the mobile station 140;

(ii) the retrieved location of the mobile station 140 according to the route id and site code;

(iii) a request for the location center 142 to perform a location estimate on the mobile station 140 and return the location estimate to the data collection system;

(iv) a request that the location center 142 retain the location for the mobile station 140 and associate with it the location of the mobile station 140 received from the data collection system.

Regarding step (iii), the location estimate may also include the steps temporarily increasing the mobile station transmitter power level

(27.3.3) Subsequently, given that the location center 142 performs as requested, when the data collection system receives the mobile station 140 location estimate from the location center, the data collection system first associates the returned mobile station location estimate with the corresponding data collection system information regarding the mobile station, and secondly, performs "reasonability" tests on the information received from the mobile station 140 for detecting, filtering and/or alerting systems and personnel whenever the postal carrier appears to be transmitting (via the mobile station 140) from a location different from what the route id and site code indicate. The following are examples of such reasonability tests:

(a) If a threshold number of postal carrier transmittals disagree with the location center 142 estimate by a predetermined distance (likely dependent upon area type), then tag these particular transmittals as problematic and mark all transmittals from the mobile station 140 as suspect for "distance" inaccuracies.

(b) If there is less than a threshold amount of time between certain postal carrier transmittals, then tag these particular transmittals as problematic and mark all transmittals from the mobile station 140 as suspect for "time" inaccuracies.

(c) If an expected statistical deviation between a sampling of the postal carrier transmittals and the location estimates from the location center 142 vary by more than a threshold amount, then tag these particular transmittals as problematic and mark all transmittals from the mobile station 140 as suspect for "statistical" inaccuracies.

(d) If an expected statistical deviation between a sampling of the times of the postal carrier transmittals and an expected timing between these transmittals vary by more than a threshold amount, then tag these particular transmittals as problematic and mark all transmittals from the mobile station 140 as suspect for "statistical" inaccuracies.

(27.3.4) When suspect or problematic mobile station location information is detected (e.g., incorrect site code) in step (27.3.3), the data collection system may perform any of the following actions:

(a) Alert the postal carrier of problematic and/or suspected inaccuracies in real time, after a certain number of transmittals or at a later time. Note that such alerts as well as positive feedback at the end of the postal carrier's route (or segments thereof) may be advantageous in that it likely inhibits the postal carrier from experimenting with transmittals from locations that are purposefully inaccurate, but at the same time provides sufficiently timely feedback to encourage a conscientious postal carrier.

(b) Alert the Postal Service of perceived discrepancies in the mobile station 140 transmittals by the postal carrier.

(c) Dispatch location center technicians to the area to transmit duplicate signals.

(27.3.5) If the transmittal(s) from the mobile station 140 are not suspect, then the data collection system communicates with the location center 142 for requesting that each location received from the mobile station 140 be stored with its corresponding retrieved location (obtained in step (d2)) as a verified location value in the Location Data Base 1129. Alternatively, if the transmittals from the mobile station 140 are suspect, then the data collection system may communicate with the location center 142 for requesting that at least some of the location data from the mobile station 140 be discarded.

Note that a similar or identical procedure to the steps immediately above may be applied with other services/workers such as courier services, delivery services, meter readers, street sweepers, and bus drivers having predetermined routes.

## WIRELESS LOCATION APPLICATIONS

After having determined wireless location from a base technology perspective, several applications are detailed below, which provide the results of the location information to a variety of users in various channels and presentation schemes, for a number of useful reasons and under various conditions. The following applications are addressed: (1.) providing wireless location to the originator or another, using either the digital air interface voice channel or a wireline channel, and an automatic call distributor; (2.) providing wireless location to the originator, or another, using either the digital air interface voice channel or a wireline channel, and a hunt group associated with the central office or a PBS group; (3.) providing wireless location to the originator or another, using either the digital air interface text paging, or short message service communications channel; (4.) providing wireless location to the originator or another, using the Internet, and in one embodiment, using netcasting or "Push" technology; (5.) selective group, multicast individualized directions with optional Conferencing; (6.) rental car inventory control and dispatch; (7.) vocalized directions and tracking; (8.) wireless location and court ruling/criminal incarceration validation; (9.) flexible delivery of wireless location information to public safety answering points; (10.) trigger-based inventory and tracking; (11.) group, e.g., family, safety and conditional notification; (12.) wireless location-based retail/merchandising services; (13.) location-based home/office/vehicle security management; (13.) infrastructure-supported wireless location using hand-actuated directional finding; (14.) infrastructure-supported intelligent traffic and highway management; (15.) Parametric-driven intelligent agent-based location services. Each of these wireless location applications is discussed in detail below.

Referring to Fig. 36, a user (the initiating caller) desiring the location of a target mobile station 140a, such as a user at a telephone station 162 which is in communication with a tandem switch 489 or a user of an mobile station 140b, or any other telephone station user, such as a computer program, dials a publicly dialable telephone number which terminates on the automatic call distributor 546 (ACD), associated with the location center 142. If the caller originated from an mobile station 102, then the call is processed via a base station 122 to a mobiles switch center 108. The mobile switch center recognizes the call is to be routed to the PSTN 124 via an interoffice trunk interface 600. The PSTN 124 completes the call to the ACD 546, via a trunk group interface 500. Note that the initiating caller could access the ACD 546 in any number of ways, including various Inter-LATA Carriers 492, via the public switched telephone network (PSTN) 124. The ACD 546 includes a plurality of telephone network interface cards 508 which provide telephony channel associated signaling functions, such as pulse dialing and detection, automatic number identification, winking, flash, off-hook voice synthesized answer, dual tone multi frequency (DTMF) detection, system intercept tones (i.e., busy, no-answer, out-of-service), disconnected, call progress, answer machine detection, text-to-speech and automatic speech recognition. Note that some of these functions may be implemented with associated digital signal processing cards connected to the network cards via an internal bus system. An assigned telephone network interface card 508 detects the incoming call, provides an off-hook (answer signal) to the calling party, then provides a text to speech (TTS) message, via an assigned text-to-speech card 512 indicating the nature of the call to the user, collects the automatic number identification information if available (or optionally prompts the caller for this information), then proceeds to collect the mobile identification number (MIN) to be located. MIN collection, which is provided by the initiating caller through keypad signaling tones, can be achieved in several methods. In one case the network card 508 can request a TTS message via text-to-speech card 512, which prompts the initiator to key in the MIN number by keypad DTMF signals, or an automatic speech recognition system can be used to collect the MIN digits. After the MIN digits have been collected, a location request message is sent to a location application 146. The location application 146, in concert with location application interface 135, in the location system 42, is in communication with the location engine 139. Note that the location engine 139 consists of the signal processing subsystem 20, and one or more location estimate modules, i.e., DA module 10, TOA/TDOA mocule 8 or HBS module 6. The location engine 139 initiates a series of messages, using the location application programming interface 136 to the mobile station 108. The location application programming interface 136 then communicates with one or more mobile switch centers 108, to determine whether or not the mobile station 140 to be located can be located. Conditions regarding the locateability of an mobile station 140 include, for example: mobile station 140 powered off, mobile station 140 not in communication range, mobile station 140 roaming state not known, mobile station 140 not provisioned for service, and related conditions. If the mobile station 140 cannot be located then an appropriate error response message is provided to the initiating caller, via e-mail, using the web server 464 in communications with the Internet 468 via an Internet access channel 472 or alternatively the error response message may be sent to a text to speech card 512, which is in communications with the initiating caller via the telephone interface card 508 and the ACD 546, which is in communication via telephony interface circuits 500 to the PSTN 124.

Note that in cases where rendering location estimate information is required on the Internet, the web server cna include the provision of a digital certificate key, thus enabling a secure, encrypted communication channel between the location web server and the receiving client. One such digital encryption key capability is a web server provided by Netscape Communications, Inc. and a digital certificate key provided by Verisign, Inc. both located in the state of California, U.S.A.

The PSTN 124 completes routing of the response message to the initiating caller via routine telephony principles, as one skilled in the art will understand. Otherwise the mobile station 140 is located using methods described in greater detail elsewhere herein. At a high level, the mobile switch center 112 is in communication with the appropriate base stations 122, and provides the location system 42 with the necessary signal and data results to enable a location estimation to be performed by the location engine 139. Once the location has been determined by the location engine 139 in terms of Latitude, Longitude and optionally height if known (in the form of a text string), the result is provided by to the initiator by inputting the location text string to a text-to-speech card 512, in communication with the assigned telephone interface card 508, via the automatic control distributor 546, completes the communication path and location response back to the initiating user via the telephone interface 500 to the PSTN

124, and from the PSTN 124 to the initiating user.

Alternatively the location results from the location application 146 could be provided to the initiating caller or Internet user via a web server 464 in communication with the Internet 468, via an Internet access channel 472 and a firewall 474. In another embodiment, the location results determined by the location application 146 may be presented in terms of street addresses, neighborhood areas, building names, and related means familiar to human users. The alternative location result can be achieved by previously storing a relationship between location descriptors familiar to humans and Latitude and Longitude range values in a map database 538. During the location request the location application 146 accesses the map database 538, providing it with the Latitude and Longitude information in the form of a primary key which is then used to retrieve the location descriptor familiar to humans. Note that to those skilled in the art, the map database 538 and associated messaging between the map database 538 and the location application 146 can be implemented in any number techniques. A straightforward approach includes defining a logical and physical data model using a relational database and designer environment, such as "ORACLE 2000" for the design and development, using a relational database, such as the "ORACLE 7.3" database.

In an alternative embodiment, the location application 146 may be internal to the location system 142, as one skilled in the art will understand.

Referring to Fig. 37, a user - the initiating caller, such as an mobile station 140b or desiring the location of an mobile station 140a, signals to the primary base station 122, in connection with the mobile switch center 108 via transport facilities 176, The mobile switch center 112 is connected to the PSTN 124, via interoffice trunks 600. The initiating user dials a publicly dialable telephone number which is then routed through an end office 496, to a telephone interface card 247, via a telephone hunt group 500. The hunt group 500 provides a telephony connection to the interface card 247 associated with the location system 228. The hunt group trunk interface 500 is provided from an end office telephone switch 496. Note that the initiating caller could access the telephony interface card 508, via hunt group trunk interface 500 in any number of ways, including an InterLATA Carrier 492, via the public switched telephone network (PSTN) 124. The hunt group trunk interface 500 is in communication with a plurality of telephone interface cards 508. The interface cards 247 provide telephony channel associated signaling functions, such as pulse dialing and detection, automatic number identification, winking, flash, off-hook voice synthesized answer, dual tone multi frequency (DTMF) detection, system intercept tones (i.e., busy, no-answer, out-of-service), disconnected, call progress, answer machine detection, text-to-speech and automatic speech recognition. An assigned network interface card 247 detects the incoming call, provides an off-hook (answer signal) to the calling party, then provides a text to speech (TTS) message indicating the nature of the call to the user, collects the automatic number identification information if available (or optionally prompts the caller for this information), then proceeds to collect the mobile identification number (MIN) to be located. MIN collection can be achieved in several methods. In one case the network card 247 can request a TTS message, generated by a voice synthesizer or text to speech card 512, which prompts the initiator to key in the MIN number by keypad tone signals, or an automatic speech recognition system can be used to collect the MIN digits. After the MIN digits have been collected, a location request message is sent to an application

146 in the location system 42. The application 146 in location system 42 initiates a series of messages to the mobile switch center 112, and optionally to the home location register 460, to determine whether or not the mobile station 140 to be located can be located. If the mobile station 140 cannot be located then an appropriate error response message is provided to the initiating caller, via e-mail, test to speech card 512, web server 464 in communications with the public Internet 468, or similar means. Alternatively the last known location can be provided, along with the time and date stamp of the last location, including an explanation that current location is not attainable. Otherwise the mobile station 140 is located using methods described in greater detail elsewhere in this patent. At a high level, the mobile switch center 112 is in communication with the appropriate base stations 122 and 122h, and provides the location system 42 with the necessary signal and data results to enable a location estimation to be performed by the location system 42. Once the location has been determined by the location system 42 in terms of Latitude, Longitude and optionally height if known (in the form of a text string), the result is provided back to the initiator by inputting the location text string to a text-to-speech card 512, in communication with the assigned telephone interface card 508. The interface card 508 then provides the audible, synthesized message containing the location estimate to the initiating caller. Alternatively the location results could be provided to the initiating caller via a web server 464 in communication with the Public Internet 468, using standard client request-response Internet protocols and technology. location system 42 access to a geographical information system or other mapping system could also be used to further enhance the user understanding of the location on a map or similar graphical display.

Referring to Fig. 38, a user (the initiating caller) desiring the location of an mobile station 140, such as a wireless user 140 who has text paging service provisioned, dials a publicly dialable telephone number, carried to the PSTN 124 which terminates on an end office 496 based hunt group interface 500, which in turn is in communication with the location system 142. The mobile switch center 112, local tandem 317 and interLATA Carrier tandem 362 are in communication with the PSTN 124, as those skilled in the art will understand. Note that the initiating caller could also be a wireline user with an ordinary telephone station 162 in communication with a local tandem 489, connected to the PSTN 124. The initiating location request user could access the telephony interface cards 512 via the hunt group 500. In other embodiments, including various Inter-LATA Carriers 492, via the public switched telephone network (PSTN) 124. The hunt group interface 500 is in communication with a plurality of telephone network interface cards 512, which are in communication with the location application 146 . The telephone interface cards 512 provide telephony channel associated signaling functions, such as pulse dialing and detection, automatic number identification, winking, flash, off-hook voice synthesized answer, dual tone multi frequency (DTMF) detection, system intercept tones (i.e., busy, no-answer, out-of-service), disconnected, call progress, answer machine detection, text-to-speech and automatic speech recognition. Note that some of these functions may be implemented with associated digital signal processing cards connected to the network cards via an internal bus system. An assigned telephony interface card 508 detects the incoming call, provides an off-hook (answer signal) to the calling party, then provides, if appropriate, a text to speech (TTS) message indicating the nature of the call to the user, collects the automatic number identification information if available (or optionally prompts the caller for this information), then proceeds to collect the mobile identification number (MIN) to be located by sending a location request message to an application 146 in the location system 42. The mobile station MIN collection, provided through the communications channel established, is sent by the initiating caller through keypad signaling tones. This MIN collection process can be achieved in several methods. In one case the telephony interface card 512 can request a text-to-speech message, generated by a text-to-speech card 512, which prompts the initiator to key in the MIN number by keypad tone signals. In another case an automatic speech recognition system can be used to collect the MIN digits. In either case after the MIN digits have been collected, a location request message is sent to the location system 142. The location system 42 initiates a series of messages to the mobile switch center 112, via the location applications programming interface (L-API) 366, and optionally to the home location register 360, to determine whether or not the mobile station 140 to be located can in fact be located. Alternatively the last known location can be provided, along with the time and date stamp of the last location, including an explanation that current location is not attainable. Conditions regarding the locateability of an mobile station include, for example: mobile station 140 powered off, mobile station not in communication range, mobile station roaming state not known, mobile station 140 not provisioned for service, and related conditions. If the mobile station 140 cannot be located then an appropriate error response message is provided to the initiating caller, via the service node for short messaging service 367. The service node is in communication with the location system 42 using a common text paging interface 369. The service node 107 accepts the location text paging message from the location system 42 and communicates a request to page the initiating caller via a typical signaling system 7 link for paging purposes, to the mobile switch center 112. The mobile switch center 112 forwards the location text page information to the initiating caller via the appropriate base stations 352 or 354, to the initiating mobile station 354. Otherwise the mobile station 140 is located using methods described in greater detail elsewhere in this patent. At a high level, the mobile switch center 112 is in communication with the appropriate base stations 352, 354, and provides the location system 42 with the necessary signal and data results to enable a location estimation to be performed by the location system 42. Once the location has been determined by the location system 42 in terms of Latitude, Longitude and optionally height if known (in the form of a text string). The location result is provided by to the initiator by inputting the location text string to the service node for short messaging service 367. The service node is in communication with the location system 42 using a common text paging interface 369. The service node 367 accepts the location text paging message from the location system 42 and communicates a request to page the initiating caller via a typical signaling system 7 link for paging purposes, to the mobile switch center 112. The mobile switch center 112 forwards the location text page information to the initiating caller via the appropriate-base stations 122a or 122b, to the initiating mobile station 140, via a text-to-speech card 512, in communication with the assigned telephone interface card 508.

Referring to Fig. 39, a user (the initiating user) desiring the location of an mobile station 140, who has a push technology tuner 484 associated with the user's client workstation 484, selects the location channel in the area, and further specifies the mobile station(s) to be located, with what frequency should the location estimate be provided, and other related parameters, such as billing information. The user's client workstation 482 is in communication with the Internet, optionally via and encrypted communications channel using, for example, Netscape's SSL 3 encryption/decryption technology. A push transmitter 472, connected to the Internet 468 via a web server 464, detects the client workstation 482 user's request. The transmitter 472 requests location update information for specified mobile identification numbers through a firewall 474 and a publisher 478, in communication with a location channel application 429 in the location system 42. The location system 42 initiates location requests for all mobile station mobile identification numbers for which location information has been subscribed to, then provides the location results to the location channel application 429.

The location system 42 initiates a series of messages to the mobile switch center 112, via the location applications programming interface (L-API) 136, and optionally to the home location register 460, to determine whether or not the mobile station 140 or others, to be located can in fact be located. Alternatively the last known location can be provided, along with the time and date stamp of the last location, including an explanation that current location is not attainable. Conditions regarding the locatability of an mobile station 140 include, for example: mobile station 140 powered off, mobile station not in communication range, mobile station 140 roaming state not known, mobile station 140 not provisioned for service, and related conditions. If the mobile station 140 cannot be located then an appropriate error response message is provided to the initiating client workstation, via the push technology components location channel application 429, publisher 478, firewall 474, transmitter 472, web server 464, public Internet 468, to the client workstation 482. A similar communication mechanism is used to provide the subscribed-to client's workstation 482 with attained location information.

Note that the location channel could in fact provide a collection of mobile station 140 mobile identification numbers for location purposes that are grouped by a particular market and/or customer organization segment. for example, location channel number 1 could provide enhanced wireless 9-1-1 service to specific public safety answering points, channel number 2 could provide periodic wireless location information of a fleet of taxi cabs belonging to a particular company, to their dispatch operator, channel 3 could provide wireless location to a control center of a military organization, channel 4 could provide wireless location information of vehicles carrying hazardous materials, to a control center, and so forth.

The location channel application 429 provides the location results to the publisher 478, which provides a method of adding the new location results to the transmitter, via firewall 474. The firewall 474, provides protection services between certain systems and the Internet, such as preventing malicious users from accessing critical computing systems.

The group multicast help, with individualized directions, are those whose are authorized and nearest, with text paging message instructions on how to drive or navigate, to reach the initiating distress caller. Alternatively optional voice synthesis technology could be used to aid one or more members to have spoken instruction giving directions and/or instructions for each member, to help them reach the distress caller.

Referring to Fig. 40, an individual having a mobile station desires to make a distress call for help, or for some other reason. The distress caller with mobile station 102 dials a special telephone number, received by base station 104, which then sends the originating call setup request to the mobile switch center 108. The mobile switch center 108 routes the originating call through the PSTN 112 to an automatic call distributor (ACD) 116. The ACD 116 selects an available telephony interface circuit 120, which answers the call and providing introductory information to the caller, such as a greeting message, progress of service, etc., using a voice synthesizer circuit card 124. Note that circuits 120 and 124 may be combined as voice response units. The telephony interface circuit 120 collects the automatic number identification information if available in the call setup message or optionally prompts the caller for this information. This MIN collection process can be achieved in several methods. In one case the network telephony interface card 120 can request a TTS message, generated by a voice synthesizer card 124, which prompts the initiator to key in their MIN number by keypad tone signals. In another case an automatic speech recognition system can be used to collect the MIN digits. In either case after the MIN digits have been collected, a location request message is sent to the location system 128. The location system or location system or center (LC) 128 initiates a series of messages to the mobile switch center 108, via the location applications programming interface (L-API) 166, to determine whether or not the mobile station 102 to be located can in fact be located. If the mobile station 102 cannot be located then an appropriate error response message is provided to the initiating caller. Otherwise the LC 128 determines the caller's location via methods discussed elsewhere in this patent. While this event is proceeding an application in the LS 128 references the initiating caller's location subscriber profile database 158 to determine if the caller allows others to locate him or her, and specifically which individuals are allowed to be informed of the caller's location.

Assuming the caller allows location information to be sent out to a select group, then the list of members mobile station identification numbers (MIN)s are extracted from the profile database 158, and an application in the LC 128 initiates a series of messages to the mobile switch center 108, via the location applications programming interface (L-API) 166, to determine the locations of each of the users' mobile station mobile identification numbers associated with the member list. Regarding those mobile station mobile identification numbers nearest the distress caller, each member mobile station is dialed via a control message sent from an application in the LC 128 to the telephony interface card 120. A voice synthesizer card 124 or text to speech circuit is also patched in the calling circuit path, to announce the purpose of the automated call to each member. The ACD 116 initiates the call request to each member via the PSTN 112, which connects to the mobile switch center 108, that ultimately rings the member mobile station 140 and 148 via base stations 132 and 152. An application in the LC 128 identifies a start and finish location destination location for a member, based on his/her current location as being the start location, and the finish location being the distress caller's location at mobile station MIN 102. The application in the LC 128 initiates a http or similar Internet compatible protocol universal resource locator (URL) request via the web server/client 162 to the public Internet 163, which terminates on a maps, directions web server 164. One such URL known to the authors is Lucent Technologies' http://www.mapsOnUs.com, which is provided for public use. The map/directions server 164 queries the map base 168 via a directions algorithm 170, and returns to the initiating http request, the location web server 162, with a list of instructions to enable a user to navigate between a start location and end location. Referring to Fig. 41, the information shown in the columns labeled "Turn #", "Directions", "And Go", and/or "Total Miles", can then be parsed from the http response information. Referring now to Fig. FIG. 40, this information can then be sent as a short text message, to the relevant mobile station 148 or 140 via the service node 182, using interface 557 to the mobile switch center 108, and relevant base stations 152 and 132, assuming each member mobile station has short message service provisioned. If this is not the case, the service node 182 will inform the application within the LS 128, which then initiates an alternative method of sending the start-finish location navigation instructions information via an appropriate voice synthesizer card 124 and associated telephony interface card 120. The interface card 120 initiates an automated call to each appropriate member's mobile station 148 and 140, via the telephony path including components ACD 116 in communication with the PSTN 112, which is in communication with the mobile switch center 108. The mobile switch center 108 completes the routing of the automated call to the appropriate mobile station 148 and 140 using base stations 152 and 132 respectively. The above process is repeated for each nearby member's mobile station, thus allowing all nearby members to be notified that the distress caller needs help, with navigation instructions to each member, which enables the member to reach the distressed caller. Variations of this application include putting each relevant party in communication with each other via a conference call capability in the ACD 116, with or without providing location information and/or start-finish navigation instructions.

An application in the location system utilizes periodic wireless location of appropriate rental cars, control circuits and control communications within the rental car, and secured transactions across the Internet, or similar means, in order to provide various tracking and control functions. Such functions allow rental car agencies to remotely control and operate their rental cars in order to reduce operating costs such as storage and maintenance, as well as provide additional conveniences and services to rental car agency customers.

Referring to Fig. 42, a vehicle 578 containing various sensors and actuators (not shown) used to, for example, lock and unlock car doors, sense door position, keypad depressions, sense the condition of the engine and various subsystems, such as brakes, electrical subsystems, sense the amount of various fluid levels, etc., is in communication with a vehicle-based local area network 572, which is in turn connected to a mobile station 140 containing asynchronous data communications capability. The vehicle-based local area network may optionally contain a computer (not shown) for control and interfacing functions. The mobile station 140 is always in communication, using the radio air interface with at least one base station 122g, and possibly other base stations 122h. The base stations 122g and 122h are in communication with the mobile switch center 112 via transport facilities 178. The mobile switch center 112 is in communication with the location system 142 and the public switched telephone network 126 via interoffice trunks 600. In addition the mobile switch center 112 is also in communication with the location system 142 via the location system - mobile switch center physical interface 178. The physical interface provides two-way connections to the location applications programming interface (L-API-MSC) 136, which is in communication with a location engine 139, which performs wireless location estimations for the mobile station, which is permanently mounted in the vehicle 578. The location engine represents key components within the location system which together comprise the capability to perform wireless location estimations. The rental car location application 146 is in communications wither the location engine 139 for purposes of initiating wireless location requests regarding the mobile station 140, as well as for receiving wireless location responses from the location engine 139. The application 146 is in communications with the automatic call distributor 546 for purposes of initiating and receiving telephone calls to and from the public switch telephone network 126, via hunt group interface 500. As one skilled in the art will appreciate, other interfaces (not shown) beyond hunt groups 500, can alternatively be used, such as ISDN interface circuits, T-carrier and the like. The application 146 is in communication with a web server and client 464, which in turn is in communication with the Internet 468 via an Internet access interface 472. As those in the art will understand, an Internet access interface is typically provided by an Internet service provider, also there are other methods which could be used to complete the Internet connection. The rental car agency contains a workstation or personal computer 582 with an Internet access interface 472 to the Internet 468. The application 146 requests of the location engine to perform a location request periodically regarding the mobile station 140, with the location response information provided the web server and client, 464. For each rental car or vehicle containing a mobile station 140, the location, as well as various information about the rental car or vehicle can be ascertained via the above described infrastructure.

An application in the location system operates in conjunction with an application in each public safety answering point (PSAP) that together provides various call handling functions to enable the PSAP to perform its work load efficiently and effectively toward unique emergency events unique to a given location. The application pair measures the number of emergency 9-1-1 wireless calls originating from a particular geographical area or location. Upon exceeding a provisional threshold value "X", the application pair traps the next incoming call from the same location and provides a call screening function via a play announcement and collect digits activity. This activity alerts the originating caller that if their call relates to an incident at a particular location, then they are the "X+1 th" caller who has already notified the PSAP, and that no further caller discussion is required. However, if the caller's intent does not relate to the incident described above, then the caller is requested to press or say "one", or some similar keypad number, which then is collected and causes the caller to be re-routed to the next available PSAP call taker. Alternatively if the originating caller does not respond within a short time period, then the call is also re-routed to the next available PSAP call taker. The voice announcement may either be synthesized by a text-to-speech card, or an PSAP operator may store a voice message which describes the incident at the above-referenced location.

## Patent Claims

We claim:

1. An apparatus for locating a first mobile station for at least transmitting and receiving radio signals, wherein said radio signals are received on a forward radio bandwidth and said radio signals are transmitted on a different reverse radio bandwidth, comprising:

a first wireless network infrastructure for communicating with said first mobile station, said first wireless network infrastructure having:

(A1) a plurality of spaced apart base stations for communicating via said radio signals with said first mobile station, and

(A2) a mobile switching center for communicating with said first mobile station, via said radio signals with the base stations, wherein said mobile switching center also communicates with said plurality of base stations for receiving measurements of said radio signals, said measurements including: (i) first measurements of said radio signals received by said first mobile station in said forward radio bandwidth, and (ii) second measurements of said radio signals transmitted by said first mobile station in said reverse radio bandwidth;

a location determining means for locating said first mobile station, wherein said location determining means receives said first and second measurements from the mobile switching center for estimating a location of said first mobile station, wherein said estimate is a function of both said first measurements and said second measurements.

2. An apparatus for locating a mobile station as claimed in Claim 1, further including an interface means between said location determining means and said mobile switching center, wherein said interface means generates a location request for a primary one of said base stations to which said first mobile signaling means is in communication.

3. An apparatus for locating a mobile station as claimed in Claim 1, further including a means for requesting data related to additional radio signals between said first mobile station and at least a second wireless network infrastructure different from said first wireless network infrastructure.

4. An apparatus for locating a mobile station as claimed in Claim 1, wherein said first wireless network infrastructure is capable of communicating at least one of voice and visual information with said first mobile station.

5. An apparatus for locating a mobile station, comprising:

a wireless network infrastructure for communicating with a plurality of mobile stations, each said mobile station for transmitting and receiving wireless signals, wherein said wireless signals are received in a forward bandwidth and said wireless signals are transmitted in a different reverse bandwidth, and, said wireless network infrastructure having a plurality of spaced apart base stations for communicating via said wireless signals with said plurality of mobile stations;

a location determining means for communicating with said plurality of mobile stations, via said radio signals with the base stations, wherein said location determining means communicates with said plurality of base stations for receiving measurements related to said radio signals for estimating a location of at least a first of said plurality of mobile stations, said measurements including: (i) first measurements of said wireless signals received by said first mobile station in said forward radio bandwidth, and (ii) second measurements of said wireless signals transmitted by said first mobile station in said reverse radio bandwidth;

wherein said location determining means estimates a location of said first mobile station using both said first measurements and said second measurements.

6. An apparatus for locating a mobile station as claimed in Claim 5, wherein said second measurements are determined from said wireless signals being received by said base stations.

7. An apparatus for locating a mobile station as claimed in Claim 5, wherein said measurements include at least one of: a delay spread, a signal strength, a ratio of energy per bit versus signal to noise, a word error rate, a frame error rate, a mobile signaling means, a power control value, a pilot index, a finger identification, an arrival time, an identification of said first mobile station for communicating with the wireless network infrastructure, a make of said first mobile station, a revision of said first mobile station, a sector identification of one of the base stations receiving said radio signals transmitted from said first mobile station.

8. An apparatus for locating a mobile station as claimed in Claim 5, wherein said radio signals are communicated using one of: CDMA, W-CDMA, TDMA and advanced mobile phone service.

9. An apparatus for locating a mobile station as claimed in Claim 5, wherein said location determining means includes a location estimator using time difference of arrival data from said measurements.

10. An apparatus for locating a mobile station as claimed in Claim 9, wherein said location estimator receives said measurements from a distributed antenna system.

11. An apparatus for locating a mobile station as claimed in Claim 9, wherein said location estimator receives active, candidate and remaining set information from said first mobile signaling means.

12. An apparatus for locating a mobile station as claimed in Claim 1, wherein said location determining means includes:

a receiving means for receiving first data related to at least one of said first measurements and said second measurements between said first mobile station and said wireless network infrastructure;

activating a first location estimator for outputting a first estimate of a location of said first mobile station when supplied with location information from said receiving means, said location information related to the first data;

outputting said first estimate of the location of said first mobile station when said first estimate has an extent less than or equal to a predetermined size;

activating a second location estimator for outputting a second estimate of a location of said first mobile station when said first location estimator does not provide said first estimate having an extent less than or equal to a predetermined size;

outputting an estimate of the location of said first mobile station when said second location estimator provides said second estimate.

13. A method for locating a wireless mobile station, comprising: transmitting, by a first short range transceiver station, a status change related to whether the mobile station and said first short range transceiver station are able to wirelessly communicate through a telephony network to a predetermined storage; storing, in said predetermined storage, said status of a mobile station, wherein said status has a first value when the mobile station communicates with said short range transceiver station as a cordless telephone, and said status has a second value when the mobile station communicates with a network of base stations, wherein said base stations are cooperatively linked for providing wireless communication; detecting, by said first short range transceiver station, a change accessing said predetermined storage for determining a location of the mobile station.

14. A method for locating a wireless mobile station, as claimed in Claim 13, wherein said short range transceiver is a home base station.

15. A method for locating a wireless mobile station, as claimed in Claim 13, wherein said predetermined storage is accessible via one of: an autonomous notification message and a request-response message.

16. A method for locating a wireless mobile station, as claimed in Claim 13, wherein said predetermined storage is a home location register.

17. A method for locating a wireless mobile station, as claimed in Claim 13, wherein said predetermined storage includes one or more of the following data items related to said mobile station: mobile station identification number, short range transceiver identification and mobile switch center identification.

18. A method for locating a wireless mobile station, as claimed in Claim 13, wherein said step of accessing includes responding to a query of said predetermined storage location using an identification of the mobile station.

19. A method for locating a wireless mobile station, as claimed in Claim 13, further including providing said status from said predetermined storage together with an identification of the mobile station to a mobile station location estimator for estimating a location of the mobile station.

20. A method for location a wireless mobile station, as claimed in claim 17, wherein said step of transmitting further includes associating said change with a predetermined fixed location and said short range transceiver identification.

21. A method for location a wireless mobile station, as claimed in claim 13, wherein said step of accessing includes translating the mobile identification number and said short range transceiver identification into a predetermined location when the status has said first predetermined value.

22. A method for location a wireless mobile station, as claimed in claim 13, further including a prior step of provisioning a translating database from a customer care system containing the location of the short range transceiver.

23. A method for locating a wireless mobile station, comprising: receiving data of wireless signals communicated between

a mobile station and a wireless network; detecting, using said first data, that the mobile station is in wireless communication with a distributed antenna system having a plurality of antennas connected in series and distributed along a signal conducting line so that there is a predetermined signal time delay between said antennas and at predetermined locations; determining a plurality of signal time delay measurements for signals transmitted between the mobile station and a collection of some of said antennas, wherein said signals are also communicated through said line; estimating a location of the mobile station using said plurality of signal time delay measurements.

24. A method for locating a wireless mobile station as claimed in Claim 23, wherein said step of estimating includes correlating each measurement of said plurality of signal time delay measurements with a unique corresponding one of said antennas.

25. A method for locating a wireless mobile station as claimed in Claim 24, wherein said step of estimating includes: identifying a plurality of antennas in said collection using correlation obtained in said step of correlating; determining a corresponding signal time delay between the mobile station and each antenna in said collection; determining a location of each antenna in said collection; estimating a location of the mobile station using said corresponding signal time delays and said locations of each antenna in said collection.

26. A method for locating a wireless mobile station as claimed in Claim 23, wherein said step of estimating includes determining, for said signal time delay measurements, a common signal time delay corresponding to transmitting signals from said distributed antenna system to a receiver of the first wireless network.

27. A method for locating a wireless mobile station as claimed in Claim 23, wherein said step of estimating includes using an absolute delay time with respect to a pilot channel for a base station on the wireless network.

28. A method for locating a wireless mobile station as claimed in Claim 23, wherein said step of estimating includes performing a triangulation using values related to one of: a signal time of arrival, and a signal time difference of arrival for time difference of arrival corresponding to each antenna in said collection.

29. A method for locating a wireless mobile station, as claimed in Claim 23 wherein said step of estimating includes a step of computing a most likely location of said mobile station using a fuzzy logic computation.

30. A method for locating a wireless mobile station as claimed in Claim 23, wherein said step of activating includes activating one of:

(a) a location estimator for determining whether the mobile station is detected by a base station of the network, wherein said base station communicates with the mobile station as a cordless telephone;

(b) a location estimator for estimating a location of the mobile station using location information obtained from said distributed antenna system;

(c) a location estimator for estimating a location of the mobile station by one of: triangulation and trilateration.

31. A method for locating a wireless mobile station, comprising: first receiving first signal characteristic measurements of

wireless signals communicated between a mobile station and a first network of base stations, wherein said base stations in the first network are cooperatively linked by a first wireless service provider for providing wireless communication; instructing the mobile station to search for a wireless signal from a second network of base stations that are cooperatively linked by a second wireless service provider for providing wireless communication, wherein said first and second wireless service providers are different; second receiving second signal characteristic measurements of wireless signals communicated between the mobile station and said second network of base stations; estimating a location of the mobile station using said first and second signal characteristic measurements.

32. A method for locating a wireless mobile station as claimed in Claim 31, wherein the mobile station is registered for a wireless communication service with the first wireless service provider, and the mobile station is not registered for the wireless communication service with the second wireless service provider.

33. A method for locating a wireless mobile station as claimed in Claim 31, wherein said step of instructing includes transmitting a command to the mobile station for instructing the mobile station to search for a signal from a base station of said second wireless service provider in a frequency bandwidth different from a frequency bandwidth for communicating with the base stations of said first wireless service provider.

34. A method for locating a wireless mobile station as claimed in Claim 31, wherein said step of instructing includes transmitting a command to the mobile station for instructing the mobile station to hand-off from said first service provider to a base station associated with said second service provider, for purposes of performing additional signal measurements.

35. A method for locating a wireless mobile station as claimed in Claim 31, wherein said first signal characteristic measurements include measurements for time delay, signal strength pairs of signal communicated from at least one of:

(a) the base stations of said first network to the mobile station, and

(b) the mobile station to the base stations of said first network, and

wherein said second signal characteristic measurements include measurements for time delay, signal strength pairs of signals communicated from the base stations of said second network to the mobile station.

36. A method for locating a wireless mobile station, comprising: receiving first data related to wireless signals communicated between a mobile station and at least a first network of a plurality of commercial mobile service provider networks of base stations, wherein for each said network, there is a plurality of base stations for at least one of transmitting and receiving wireless signals with a plurality of mobile stations; instructing the mobile station to communicate with a second network of the plurality of networks for supplying second data; activating a mobile station location estimator, when said first and second data are obtained for providing an estimate of a location of the mobile station.

37. A method for locating a wireless mobile station, as claimed in Claim 36, wherein said second network includes a

second plurality of base stations, wherein a majority of base stations in said second plurality of base stations has a location different from the locations of base stations in said first network.

38. A method for locating a wireless mobile station, as claimed in Claim 36, wherein at least one of said first and second data includes signal characteristic measurements of communication with the mobile station for a time interval of less than 10 seconds.

39. A method for locating a wireless mobile station, comprising: first receiving first signal characteristic measurements of wireless signals communicated between a mobile station and a first network of base stations, wherein said base stations in the first network are cooperatively linked by a first wireless service provider for providing wireless communication; instructing a second network of base stations that are cooperatively linked by a second wireless service provider for providing wireless communication so that the second network searches for wireless signals from the mobile station, wherein said first and second wireless service providers are different; second receiving second signal characteristic measurements of wireless signals communicated between the mobile station and said second network of base stations; estimating a location of the mobile station using said first and second signal characteristic measurements.

40. A method for locating a wireless mobile station, as claimed in Claim 39, further including a step of requesting the mobile station to raise it's transmitter power level to a predetermined level, prior to said step of instructing.

41. A method for locating a wireless mobile station, comprising: receiving, by a receiving means, first data related to wireless signals communicated between a mobile station and at least a first network of a plurality of commercial mobile service provider networks, wherein for each said network, there are a plurality of communication stations for at least one of transmitting and receiving wireless signals with a plurality of mobile stations; first activating a location estimator for providing a first estimate of a location of the mobile station when supplied with first location information from said receiving means, said first location information related to the first data;

when one of: (a) said first estimate does not exist, and (b) said first estimate has an extent greater than or equal to a predetermined size, the steps (A1) and (A2) are performed:

(A1) instructing the mobile station to communicate with a second network of the plurality of networks for supplying second data to said receiving means, wherein said second data is related to wireless signals communicated between the mobile station and the second network;

(A2) second activating said location estimator a second time for providing a second estimate of a location of the mobile station when supplied with additional location information from said receiving means, said additional location information related to the second data;

outputting at least one of the estimates of the location of the mobile station provided by said location estimator when said location estimator provides at least one estimate of the location of the mobile station.

42. A method for locating a wireless mobile station as claimed in Claim 41, wherein said additional location information

and said first location information are utilized together by said location estimator.

43. A method of locating a wireless mobile station as claimed in Claim 41, wherein said communication stations include wireless base stations for one of CDMA, TDMA, and GSM.

44. A method of locating a wireless mobile station as claimed in Claim 43, wherein said communication stations include home base stations.

45. A method of locating a wireless mobile station as claimed in Claim41, wherein the mobile station includes one of: a CDMA transmitter, a TDMA transmitter, and a GSM transmitter, and a AMPS transmitter.

46. A method for locating a wireless mobile station as claimed in Claim 41, wherein one or more of said activating steps includes :

(a) said location estimator for determining whether the mobile station is detected by a communication station which communicates with the mobile station as a cordless telephone;

(b) said location estimator for estimating a location of the mobile station using location information related to data from a distributed antenna system;

(c) said location estimator for estimating a location of the mobile station by one of: triangulation and trilateration.

47. A method for locating a wireless mobile station as claimed in Claim 41, wherein said predetermined extent is less than one thousand feet.

48. A method for locating a wireless mobile station, comprising: receiving, by a receiving means, first data related to wireless signals communicated between a mobile station and at least a first network of one or more commercial mobile service provider networks, wherein for each said network, there is a different plurality of base stations for at least one of transmitting and receiving wireless signals with a plurality of mobile stations; activating a first location estimator for outputting a first estimate of a location of the mobile station when supplied with location information from said receiving means, said location information related to the first data; outputting said first estimate of the location of the mobile station when said first estimate has an extent less than or equal to a predetermined size; activating a second location estimator for outputting a second estimate of a location of the mobile station when said first location estimator does not provide said first estimate having an extent less than or equal to a predetermined size; outputting an estimate of the location of the mobile station when said second location estimator provides said second estimate.

49. A method for locating a wireless mobile station as claimed in Claim 48 further including a step of instructing the mobile station to communicate with a second network of the plurality of networks for supplying second data to said receiving means, wherein said second data is related to wireless signals communicated between the mobile station and the second network.

50. A method for locating a wireless mobile station as claimed in Claim 49, wherein said step of instructing includes a

step of instructing the mobile station to hand-off to said second network for synchronizing timing signals and performing measurements between the mobile station an said second network.

51. A method for locating a wireless mobile station as claimed in Claim 48, wherein one or more of said activating steps includes activating one of:

(a) a location estimator for determining whether the mobile station is detected by one of the base stations which communicates with the mobile station as a cordless telephone;

(b) a location estimator for estimating a location of the mobile station using location information related to data from a distributed antenna system;

(c) a location estimator for estimating a location of the mobile station by one of: triangulation and trilateration.

52. A method for locating a mobile station, comprising: receiving, by said mobile station, a request control message from one of a plurality of base stations, wherein said message is received by a receiving antenna of said mobile station; the control message providing information related to said message to at least one of a control processor and a searcher receiver in said mobile station; determining, using at least one of said control processor and said searcher receiver, a plurality of pairs of radio signal strength related values and corresponding signal time delays for a wireless communication between said mobile station and at least a first of the base stations, wherein for at least some of said pairs, said signal time delays are different, and for each pair, said signal strength related value for said pair is obtained using a signal strength of said communication at said corresponding signal time delay of said pair; transmitting signals for said pairs to one or more of the base stations via a transmitting antenna of said mobile station; routing data for at least one of said pairs from said one or more base stations to a mobile station location estimator for estimating a location of said mobile station.

53. A method for locating a mobile station, as claimed in Claim 52, wherein said step of receiving uses one of a CDMA, an AMPS, a NAMPS and a TDMA wireless standard.

54. A method for locating a mobile station, as claimed in Claim 52, wherein said step of determining is performed for a wireless communication between said mobile station and each of a plurality of the base stations.

55. A method for locating a mobile station, as claimed in Claim 52, wherein each of said signal time delays is included within a predetermined corresponding time delay spread.

56. A method for locating a mobile station, as claimed in Claim 52, wherein said step of determining includes a step of instructing, by said control processor, said searcher receiver to output a plurality of said radio signal strength related values for a plurality of fingers resulting from said communication from said first base station to said mobile station.

57. A method for locating a mobile station, as claimed in Claim 52, wherein said step of determining includes inputting data for said pairs to a modulator for modulating said data prior to said step of transmitting.

58. A method for locating a mobile station, as claimed in Claim 57, further including a step of establishing a software controllable data connection between said control processor and a mobile station component including at least one of: a user digital baseband component and said modulator, wherein said connection inputs said data to said component.

59. A method for locating a mobile station, as claimed in Claim 52 further including a step of providing said data for said pairs to a mobile station location estimating system having a first mobile station location estimating component using time difference of arrival measurements for locating said mobile station via one of trilateration and triangulation.

60. A method for locating a mobile station, as claimed in Claim 59, wherein said step of providing includes selecting one of: said first mobile station estimating component, a second mobile station estimating component using data obtained from a distributed antenna system, and a third mobile station estimating component for using data obtained from activation of a home base station.

61. A method for locating a mobile station, as claimed in Claim 60, further including a step of computing a most likely location of said mobile station using a fuzzy logic computation.

62. A method for locating a mobile station, as claimed in Claim 61, wherein said step of computing is performed by said second mobile station estimating component for determining a most likely floor that said mobile station resides in a multi-story building having a distributed antenna system.

63. A method for locating a mobile station, as claimed in Claim 59, further including a step of requesting data for additional pairs of radio signal strength related values and corresponding signal time delays for a wireless communication between said mobile station and at least a second base station of a commercial mobile radio service provider different from a commercial mobile service provider for said first base station.

64. A method for obtaining data related to wireless signal characteristics, comprising: providing a user with a mobile station for use when the user traverses a route having one or more predetermined route locations, wherein one or more of the route locations have a corresponding telephone number and a corresponding description stored in the mobile station; performing the following substeps when the user visits each of the route locations: activating a call to said corresponding telephone number; transmitting a code identifying the route location when the user is substantially at the route location; storing an association of:

(a) signal characteristic measurements for wireless communication between the mobile station and one or more base stations, and

(b) a unique identifier for the route location obtained using said code transmitted by said call;

Wherein said stored signal characteristic measurements are accessible using said unique identifier.

65. A method as claimed in Claim 64, wherein said unique identifier corresponds to one of: (a) an address for the route

location, and (b) a latitude and longitude of the route location.

66. A method as claimed in Claim 64, wherein said route is periodically traversed by a user having a mobile station for accomplishing said step of performing.

67. A method as claimed in Claim 64, wherein said step of storing includes retaining said signal characteristic measurements in a data storage for analyzing signal characteristic measurements of wireless communications between mobile stations and a wireless infrastructure of base stations.

68. A method as claimed in Claim 64, further including, prior to said step of activating, a step of determining, by the user, that a display on the mobile station uniquely identifies that said corresponding description of the route location is available for calling said corresponding telephone number and transmitting said identifying code.

69. A method as claimed in Claim 64, wherein said step of storing includes: obtaining a phone number identifying the mobile station; providing said phone number identifying the mobile station to a commercial mobile radio service provider in a request for said signal characteristic measurements.

70. A method as claimed in Claim 64, wherein said step of storing includes using a phone number identifying the mobile station in combination with said transmitted identifying code for determining said unique identifier.

71. A method as claimed in Claim 64, wherein said corresponding description includes at least one of: a textual description of its corresponding route location, and an address of its corresponding route location.

72. A method as claimed in Claim 64, further including steps of: associating said identifying code for the route location and said unique identifier in a data storage prior to performing said step of performing; accessing said data storage using said identifying code for obtaining said unique identifier in said step of storing.

73. A method as claimed in Claim 64, further including a step of accessing said stored signal characteristic measurements for enhancing a performance of a process for locating mobile stations.

74. A method as claimed in Claim 64, wherein at least two of said one or more base stations are in networks of different commercial mobile radio service providers.

75. A method as claimed in Claim 64, further including a step of filtering said signal characteristic measurements so that when said signal characteristic measurements are suspected of being transmitted from a location substantially different from the route location, said step of storing is one of: (a) not performed, and (b) performed so as to indicate that said signal characteristic measurements are suspect.

76. A method as claimed in Claim 75, wherein said step of filtering includes at least one of: (a) determining an amount by which an estimated location of the mobile station using said signal characteristic measurements differs from a location of the mobile station obtained from said unique identifier; (b) determining whether a predetermined amount of time has elapsed between successive performances of said step of activating.

77. A method for locating a wireless mobile station, comprising:

first receiving first signal characteristic measurements of wireless signals communicated between a mobile station and a first network of base stations, wherein said first signal characteristic measurements includes:

(a) one or more pairs of wireless signal strength related values and corresponding signal time delays for a wireless communication between the mobile station and at least a first of the base stations;

(b) data identifying operational characteristics of the mobile station including information related to a signal transmission power for the mobile station and information for determining a maximum transmission power level of the mobile station;

adjusting, for at least one of said pairs, its corresponding wireless signal strength, using said data, thereby obtaining corresponding adjusted pairs, wherein each adjusted pair has the corresponding adjusted signal strength, and wherein said adjusted signal strength is an expected signal strength of a predetermined standardized mobile station transmitter power level having a predetermined maximum transmission power and operating at a predetermined transmission power level;

outputting second signal characteristic information, obtained using said adjusted signal strength, to a mobile station location estimator for determining a location estimate of said first mobile station.

78. A method for locating a mobile station as claimed in Claim 77, further including applying sequence of one or more signal processing filters to one of: said pairs and said adjusted pairs.

79. A method for locating a mobile station as claimed in Claim 78, wherein said sequence of filters is dependent upon a corresponding mobile station location estimator.

80. A method for locating a mobile station as claimed in Claim 79, wherein said sequence of filters is pipelined so that for first and second filters of said sequence, an output of said first filter is an input to said second filter.

81. A method for locating a mobile station as claimed in Claim 79, wherein said filters include Sobel, Weiner, median and neighbor.

82. A method for locating a wireless mobile station, comprising:

first receiving first signal characteristic measurements of wireless signals communicated between a mobile station and a first network of base stations, wherein said first signal characteristic measurements includes one or more pairs of wireless signal strength related values and corresponding signal time delays for a wireless communication between the mobile station and at least a first of the base stations;

categorizing said pairs into categories according to ranges of signal strength related values and ranges of corresponding signal time delays for obtaining a representation of a frequency of occurrence of said one or more pairs in said categories;

applying one or more filters to said representation for one of: (a) reducing characteristics of said representation that are expected to be insufficiently repeatable for use in identifying a location of the mobile station, and (b) enhancing a signal to noise ratio;

supplying an output obtained from said step of applying to a mobile station location estimator;

estimating a location of the mobile station using said mobile station location estimator.

83. A method for locating a wireless mobile station as claimed in Claim 82, further including a step of requesting data for additional pairs of wireless signal strength related values and corresponding signal time delays for a wireless transmission between the mobile station and at least a second base station of a second network of base stations different from the base stations of the first network, wherein said first and second networks communicate with the mobile station in different signal bandwidths.

84. A method for locating a wireless mobile station as claimed in Claim 83, wherein the first network is operated by a first commercial mobile radio service provider and the second network is operated by a second commercial mobile radio service provider.

85. A method for locating a wireless mobile station as claimed in Claim 82, wherein said representation corresponds to a histogram.

86. A method for locating a wireless mobile station as claimed in Claim 82, further including a step of normalizing one of: (a) said pairs, and (b) values corresponding to said output.

87. A method for locating a wireless mobile station as claimed in Claim 23, wherein said step of activating further includes the step of applying a fuzzy logic module which further discretizes the location estimate provided from one of:

(a) a location estimator for estimating a location of the mobile station using location information obtained from said distributed antenna system;

(b) a location estimator for estimating a location of the mobile station by one of: triangulation and trilateration.

88. A method for contacting a telephony station, comprising: associating, by a user, a particular telephony number with a collection of one or more telephony station numbers of telephony stations with which the user desires to communicate when said particular telephony number is called from a predetermined telephony station; receiving said particular telephony number from the predetermined telephony station; determining a location of said predetermined telephony station and at least some of said telephony stations having telephony station numbers in said collection; selecting a first of said telephony stations having telephony station numbers in said collection, wherein said first telephony station is selected according to a location of said predetermined telephony station and a location of first telephony station; transmiting a user desired message to said first telephony station.

89. A method for locatin a mobile station, comprising: establishing, by a user of a particular mobile station, a collection of identities of one or more persons having permission to receive a location of said particular mobile station; receiving a request by a first of said persons for locating said particular mobile station; determining a location of said particular mobile station in response to said request, said location determined using measurements of wireless transmissions between said particular mobile station and a first wireless network of base stations, wherein said base stations are cooperatively linked for wireless communication; outputting said location to the first person.

90. A method as claimed in Claim89, wherein said step of determining includes using measurements of wireless tramsmissions between said particular mobile station and a second wireless network of base stations provided by a different commercial wireless service provider from a commercial wireless service provider for the first wireless network.

91. An apparatus for locating a mobile station as claimed in Claim 3, further including a means for providing a location estimate using the Internet.

92. An apparatus for locating a mobile station as claimed in Claim 3, further including a means for providing a location estimate using the Internet.

93. An apparatus for locating a mobile station as claimed in Claim 3, further including a means for providing a location estimate using digital certificate keys and the Internet.

94. An apparatus for locating a mobile station as claimed in Claim 91, further including a means for providing a location estimate using push technology on the Internet.

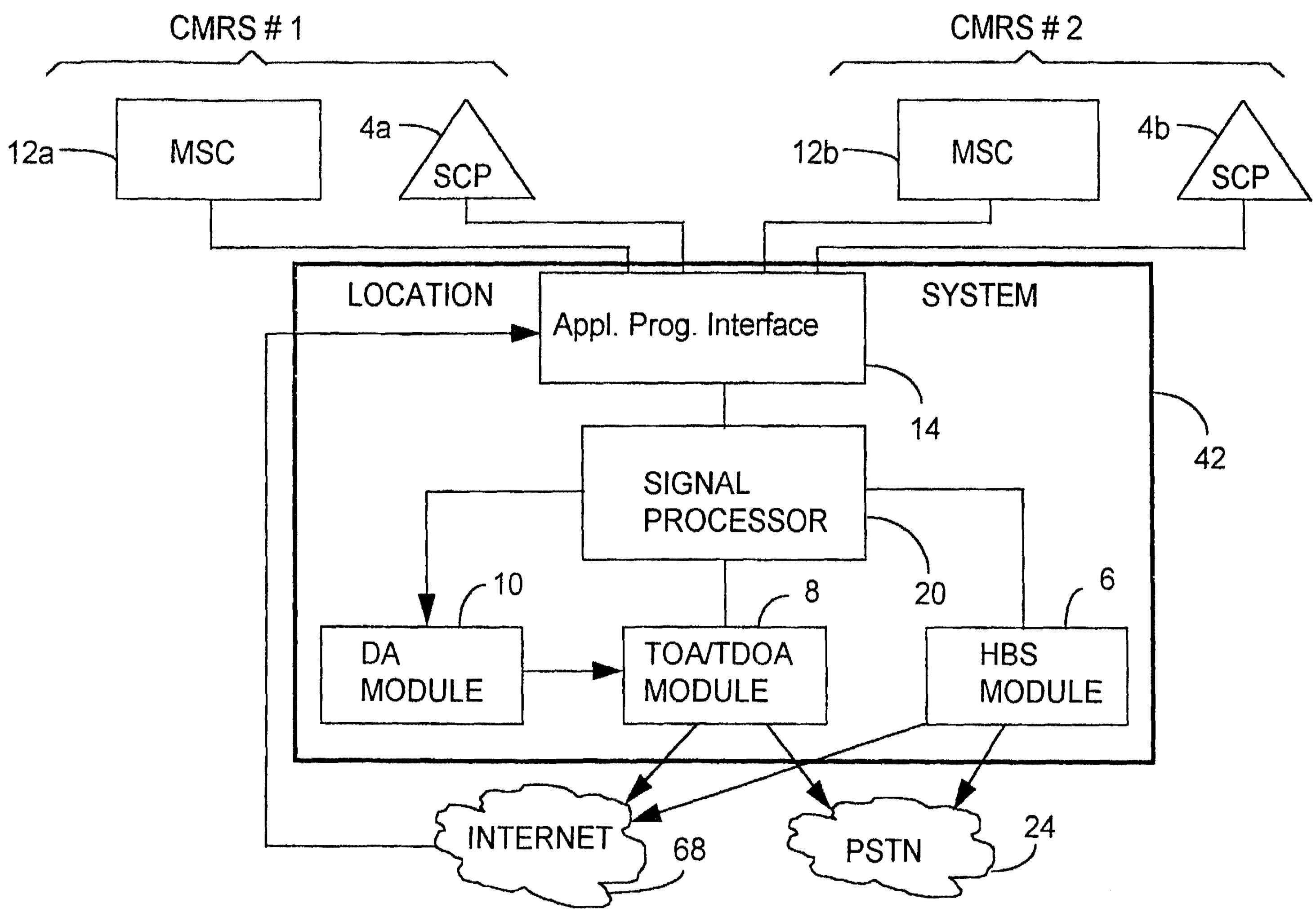



FIG. 1: WIRELESS LOCATION USING MULTIPLE CMRSs

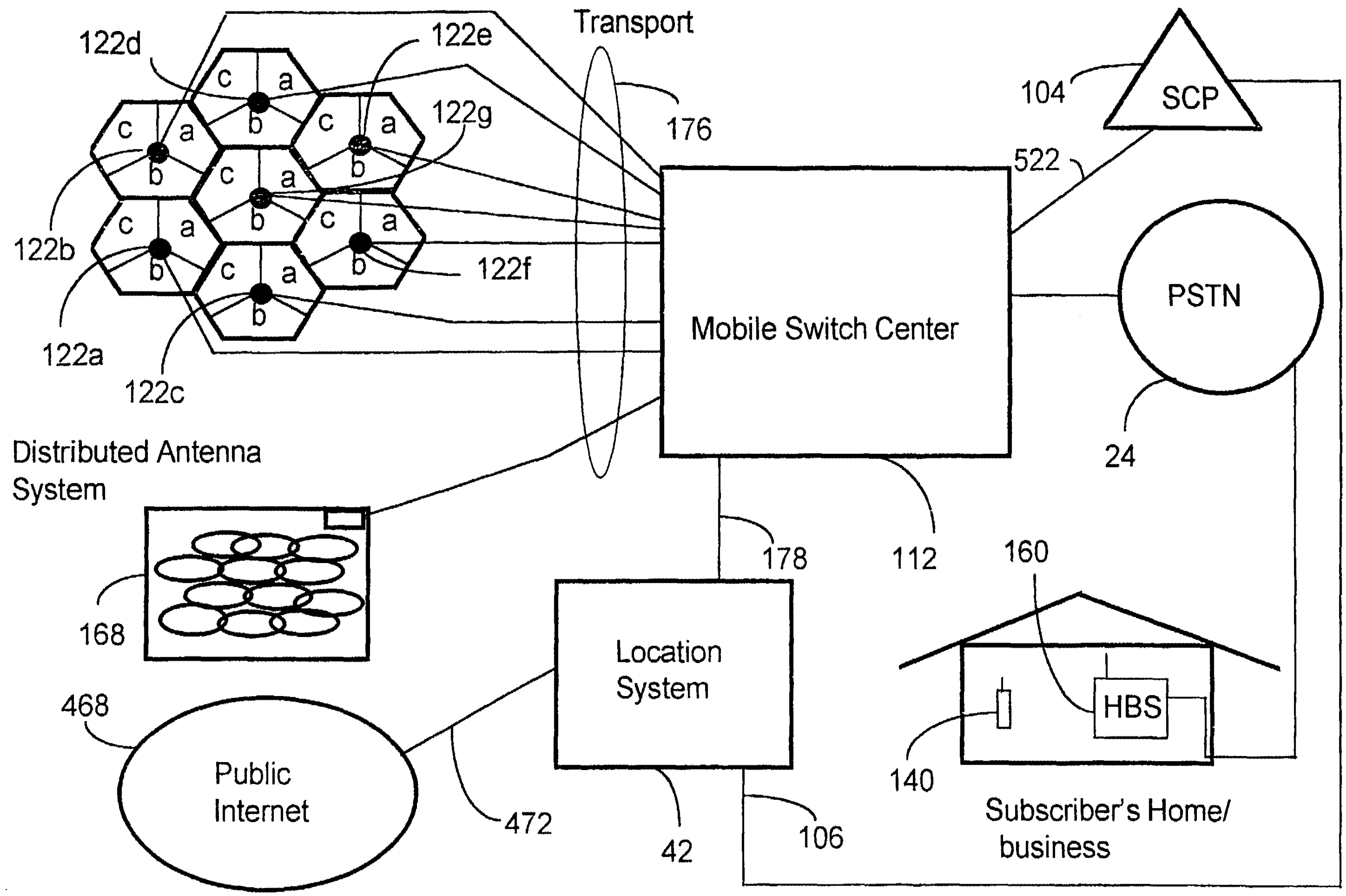



Fig. 2: WIRELESS LOCATION INTELLIGENT NETWORK ARCHITECTURE

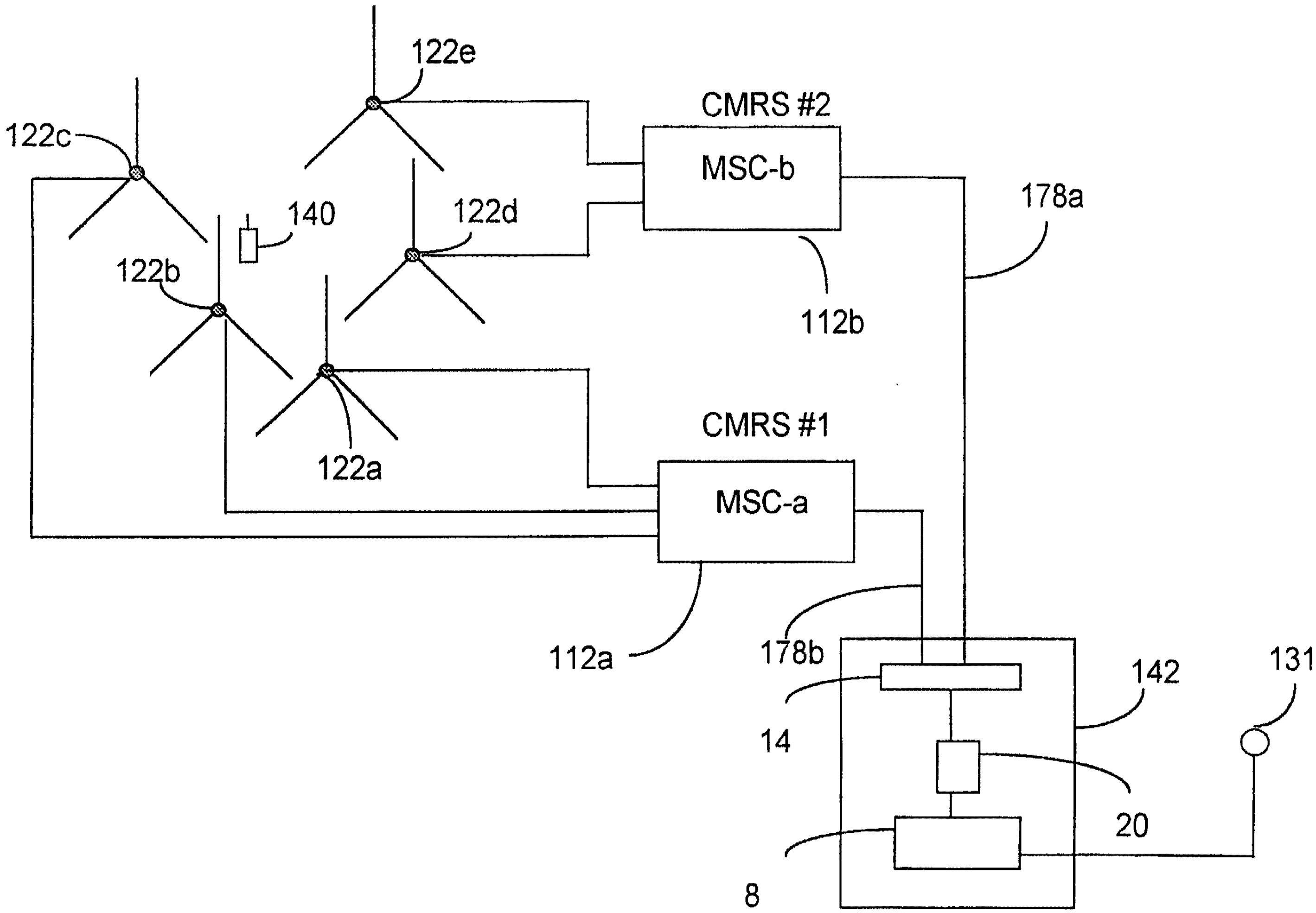



FIG. 3: SHARING CMRS BASE STATION INFRASTRUCTURE

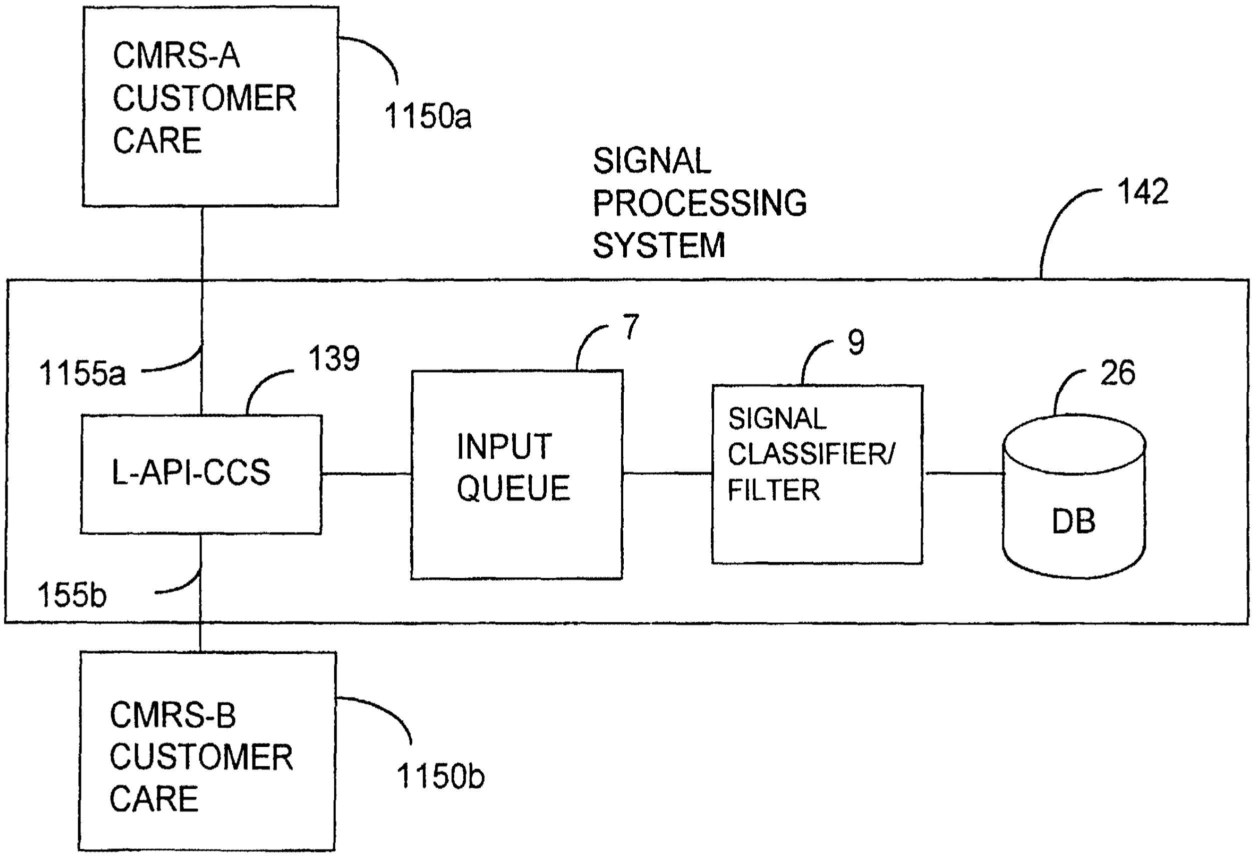



FIG. 4: LOCATION PROVISIONING VIA MULTIPLE CMRS

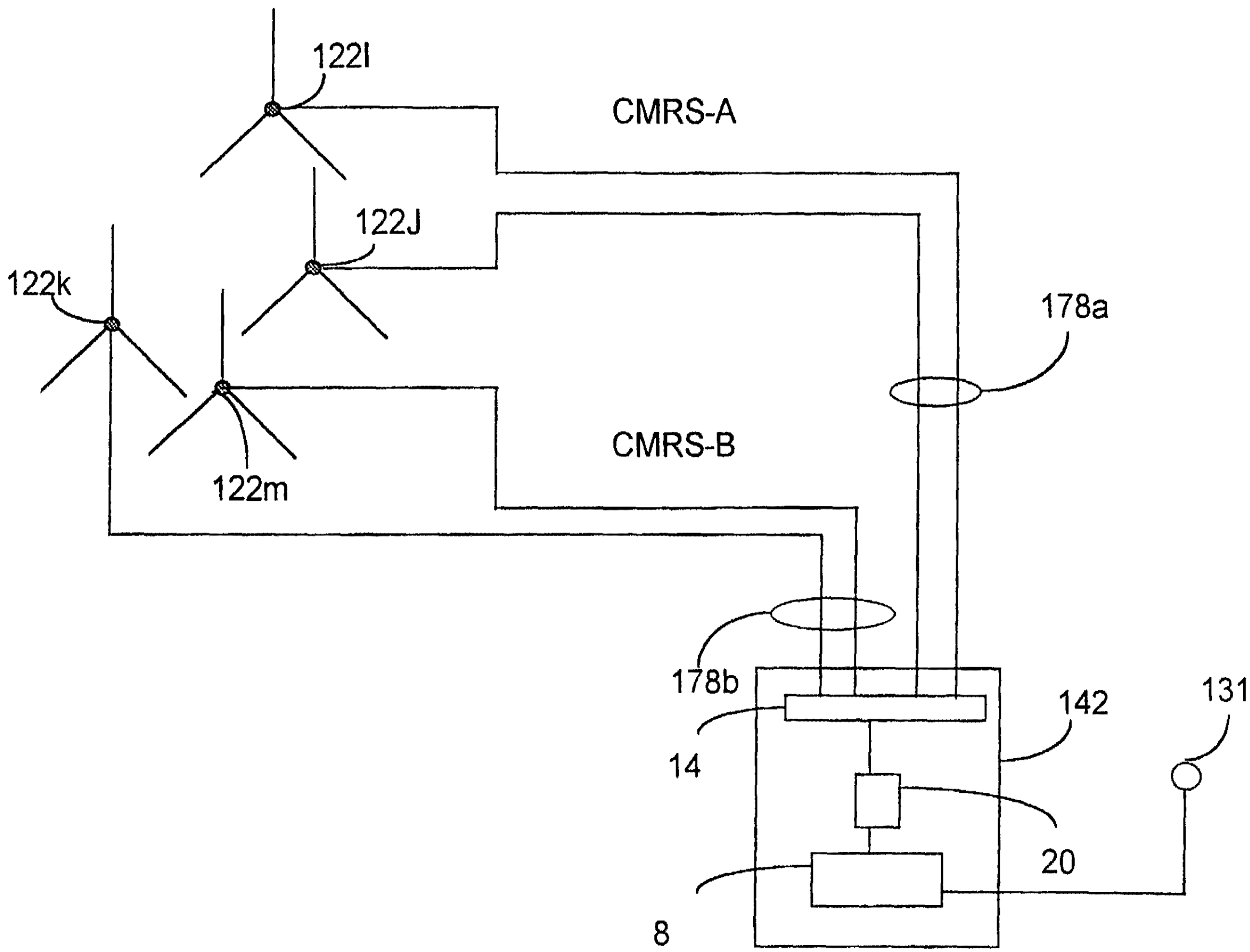



FIG. 5: LOCATION CENTER BASE STATION ACCESS, MULTIPLE CMRS

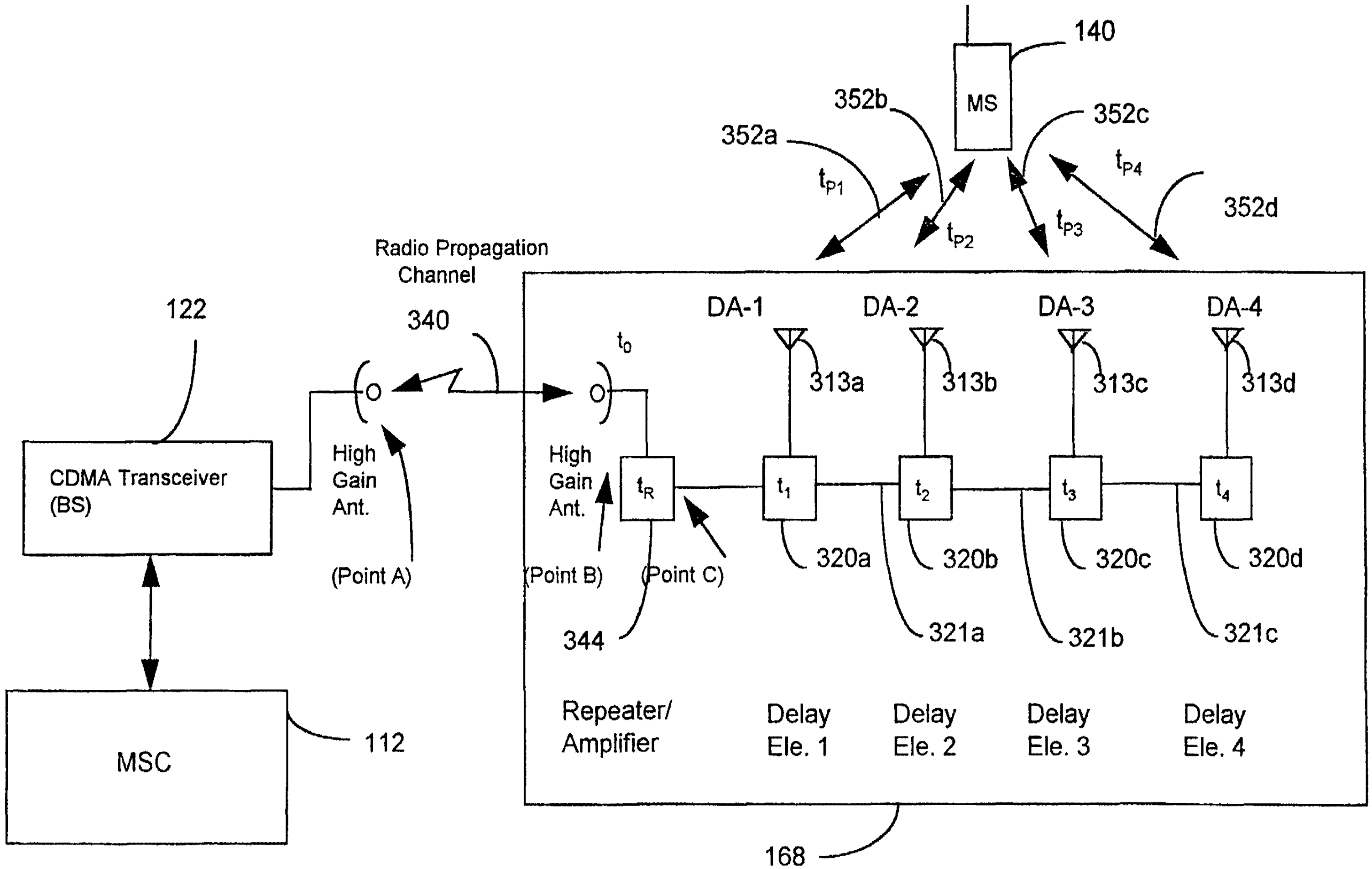



FIG. 6: DISTRIBUTED ANTENNA DELAY ChARACTERIZATION

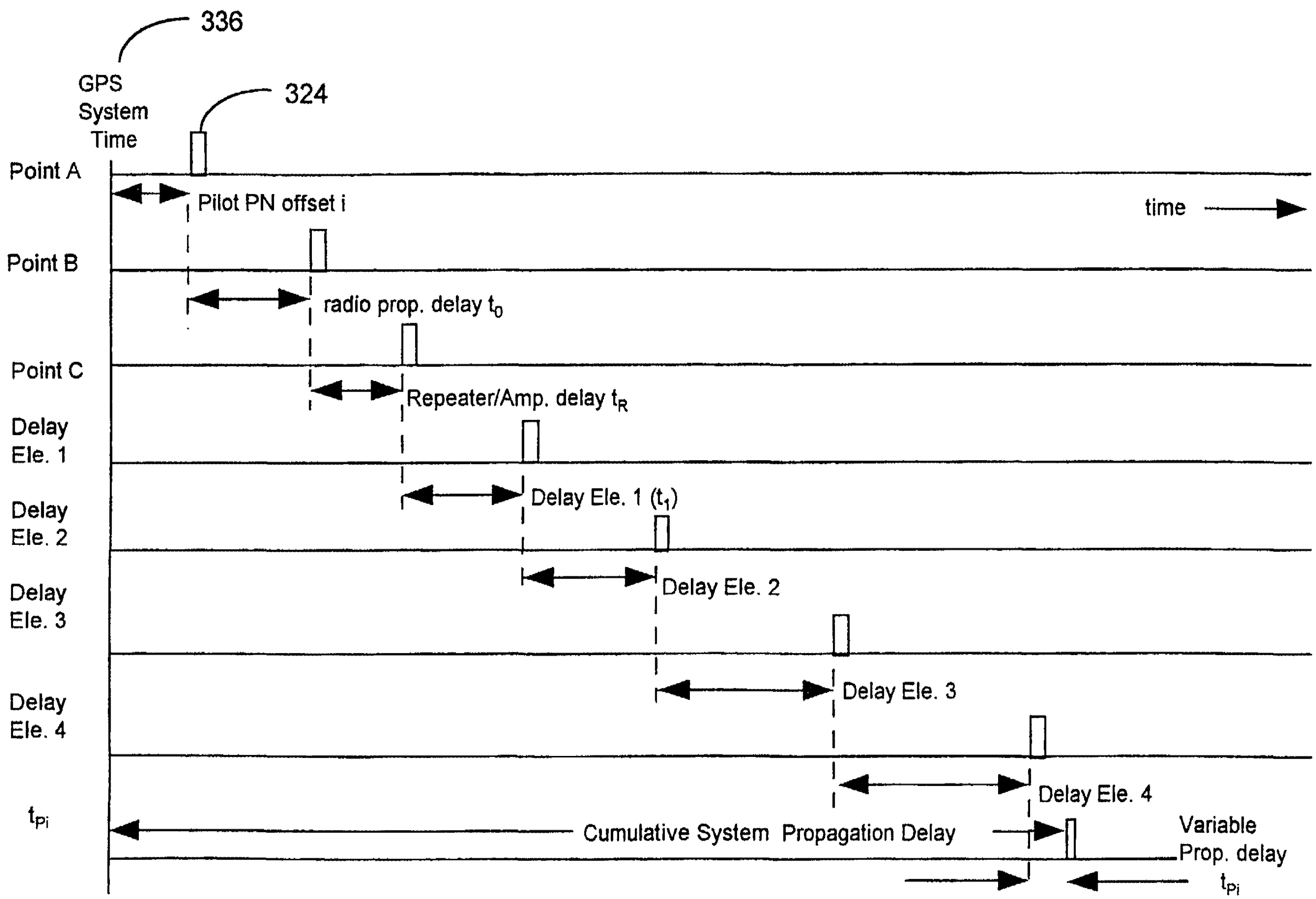



Fig. 7: DA System Timing Diagram

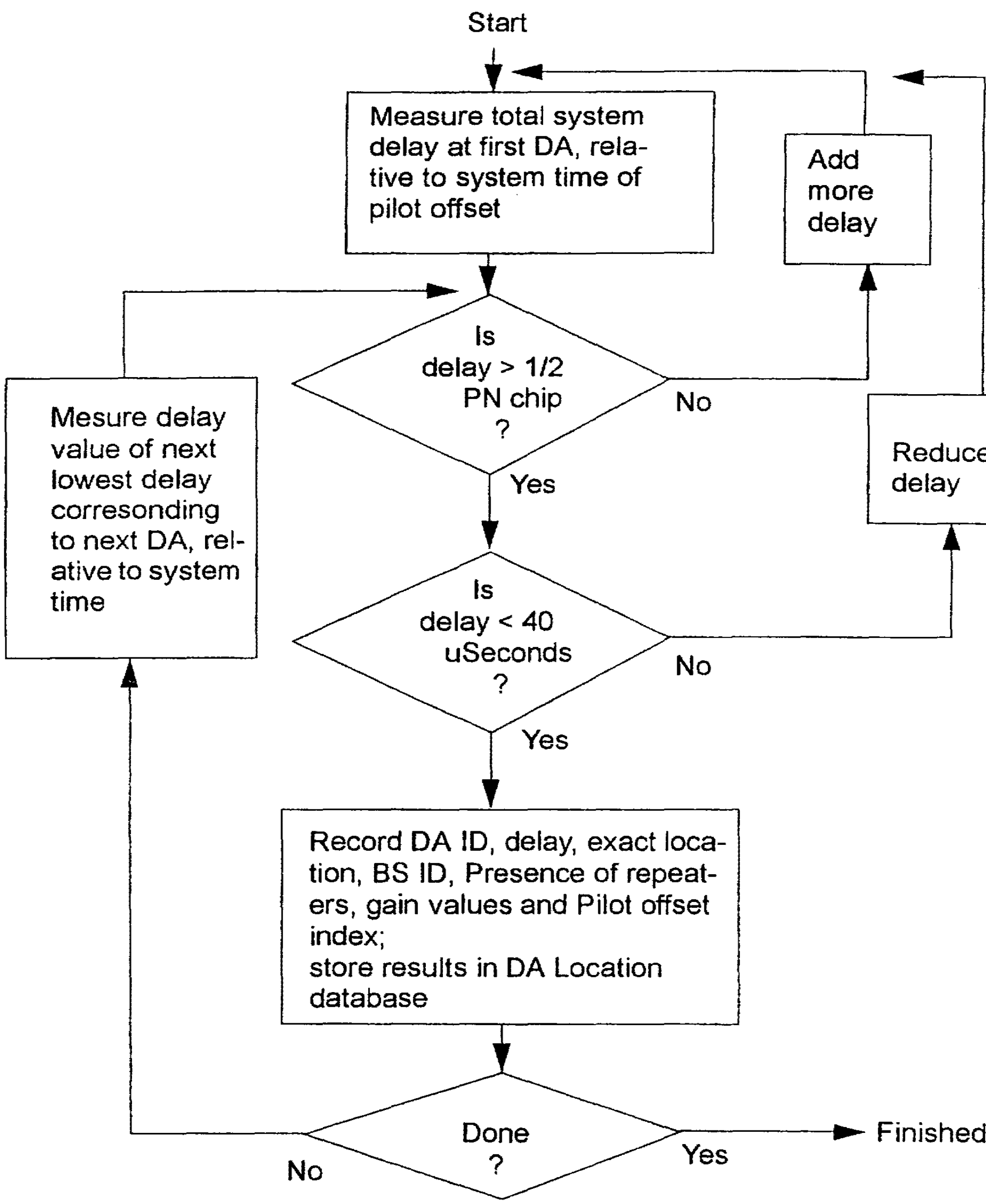



FIG. 8: DA Installation Procedure for Wireless Location

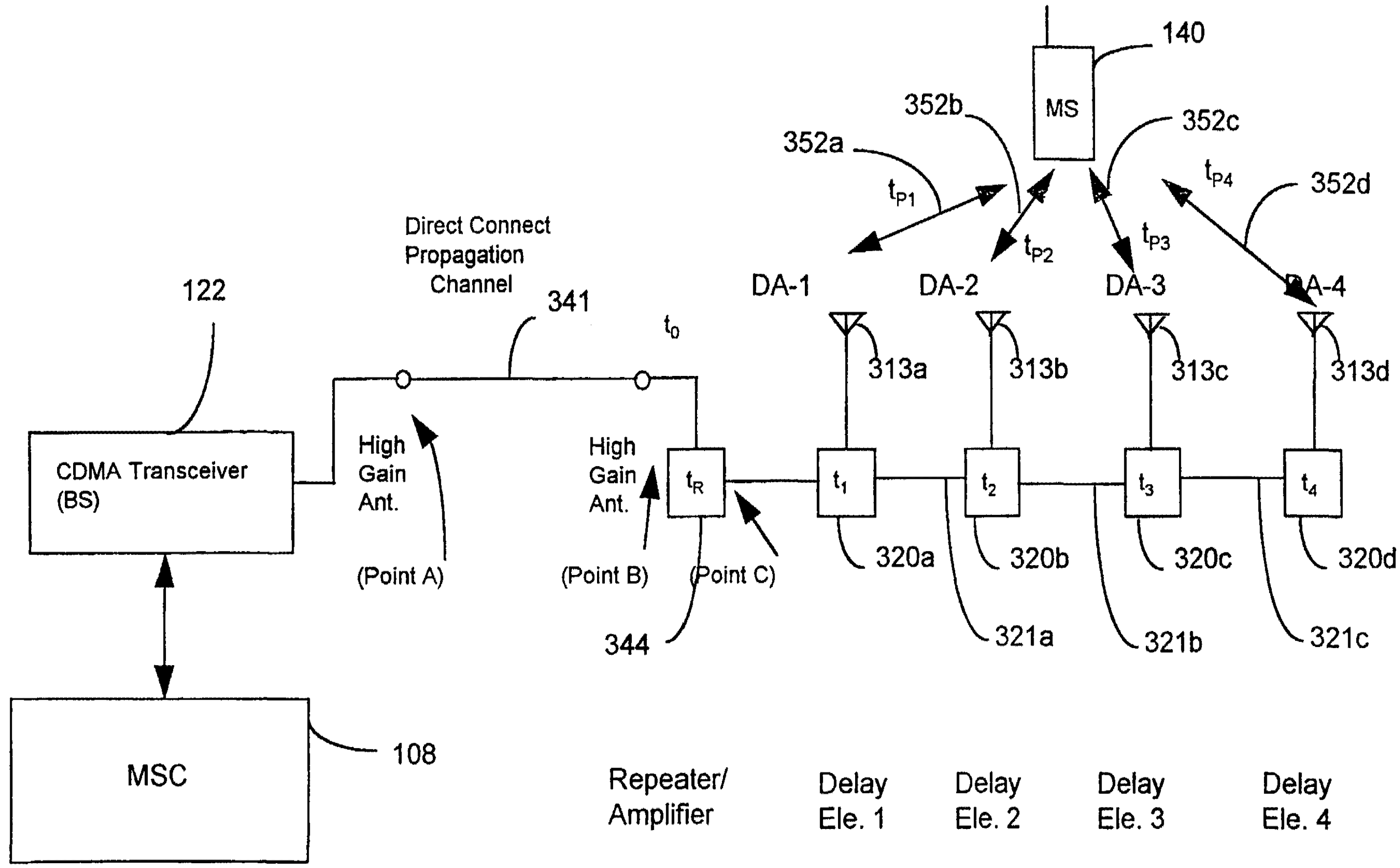



**Figure 9: A Direct-Connect Distributed Antenna System**

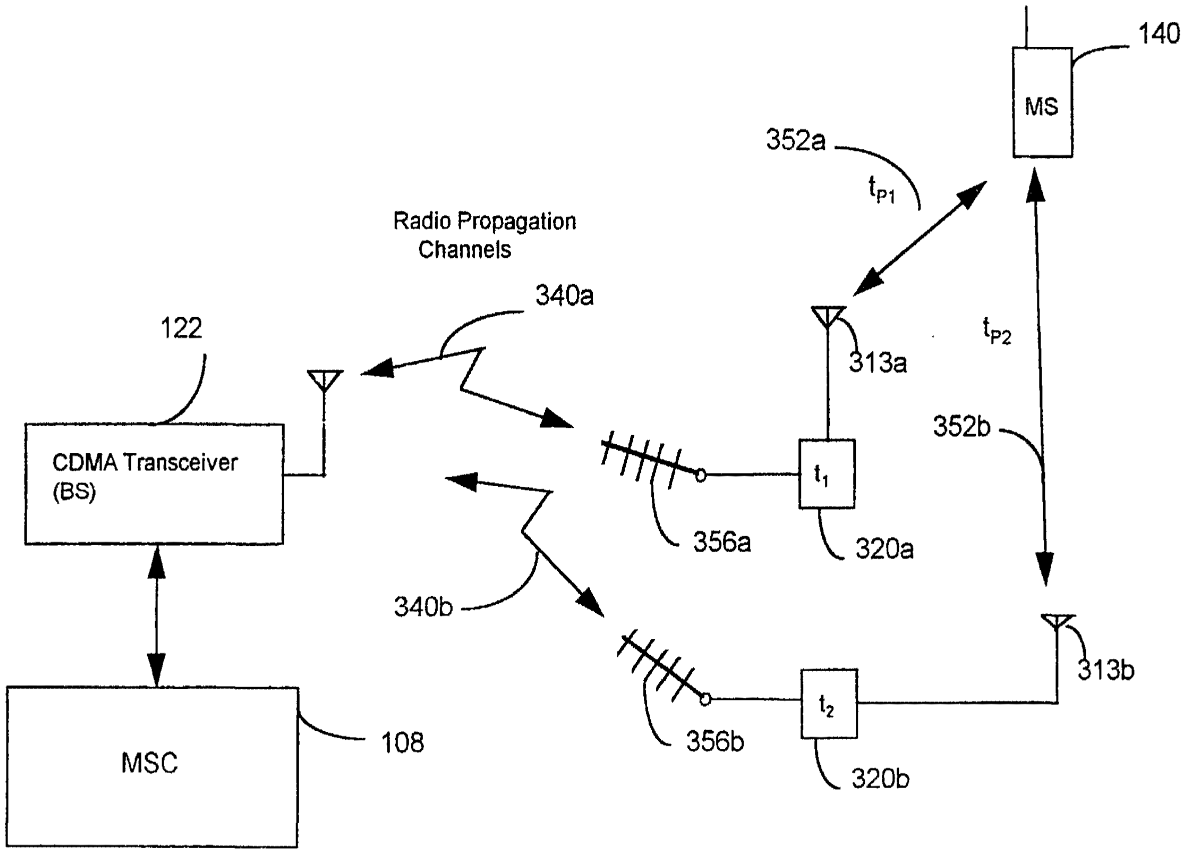



Figure 10: Multipoint Distributed Antenna System

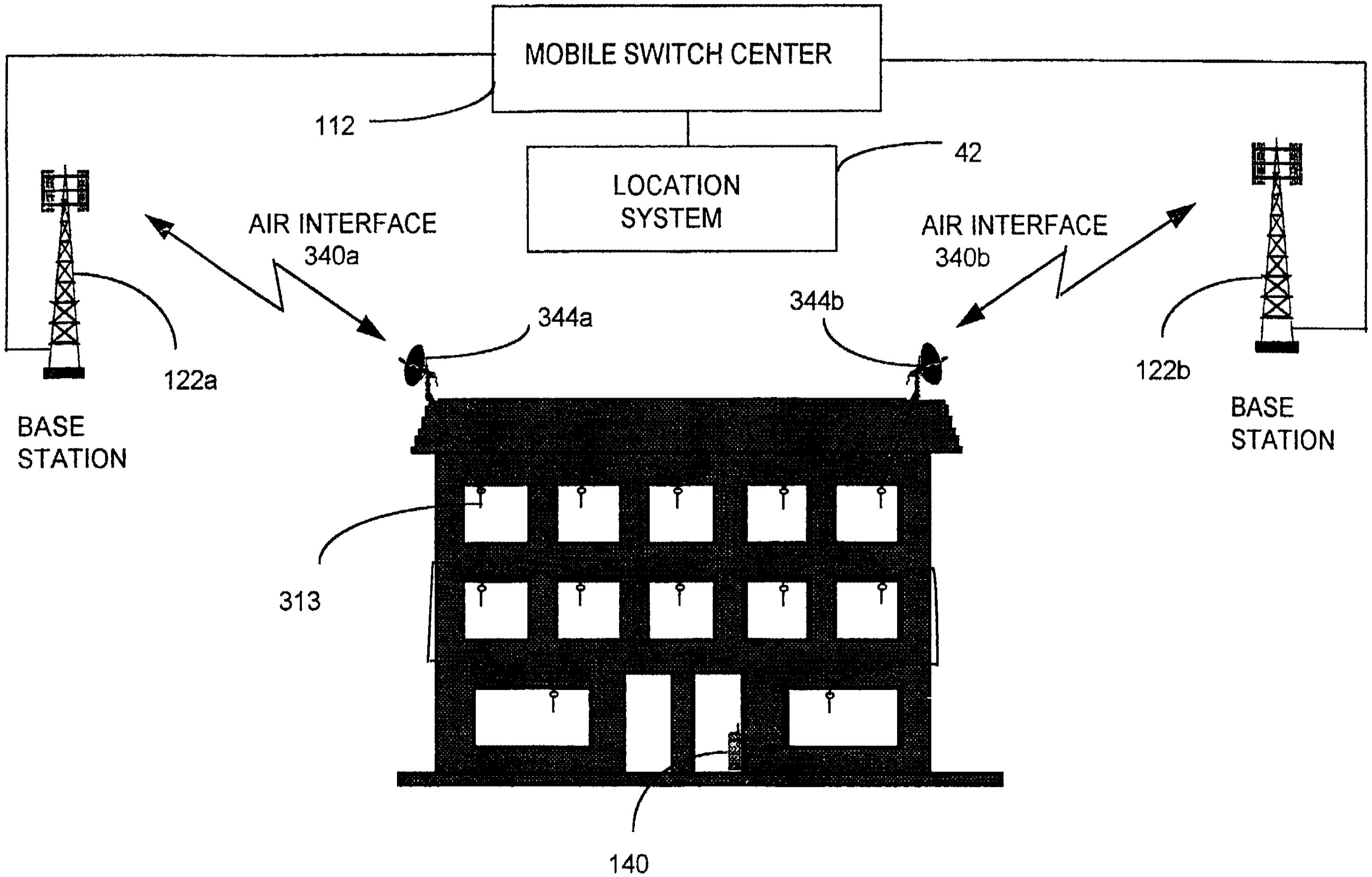



FIG. 11: Dual-Microwave Access Distributed Antenna Example

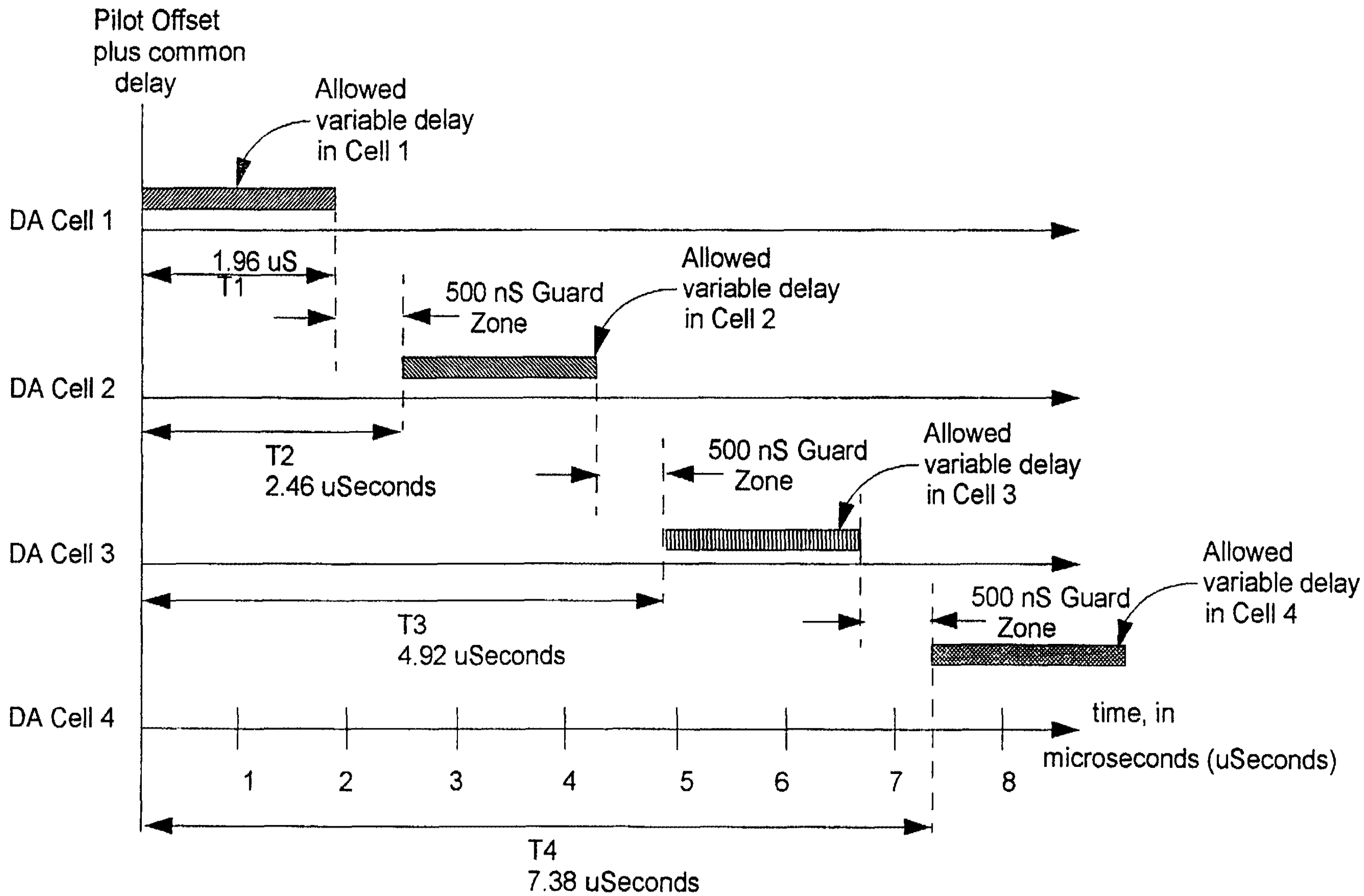
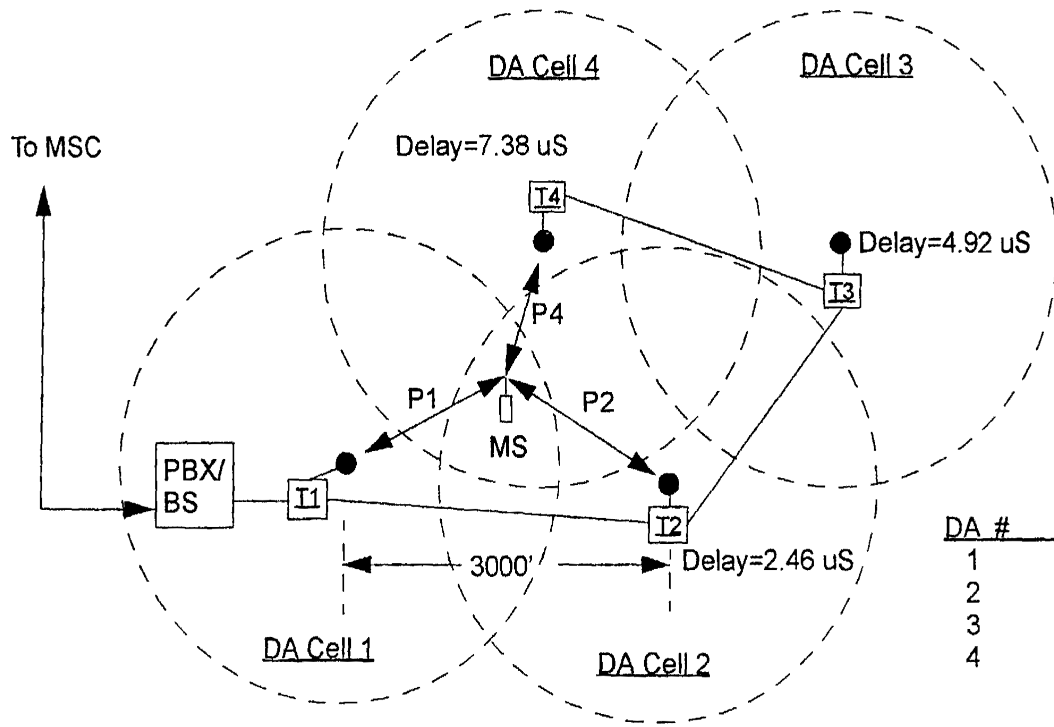



FIG. 12: ALLOWABLE DELAY SPREADS AMONG DA CELLS

All distributed omni antennas have a maximum coverage radius of 2,000 feet




| DA # | X,Y Location |
|---|---|
| 1 | (0,0) |
| 2 | (3000, -20) |
| 3 | (1600, 2800) |
| 4 | (1600, 2800) |

**FIG. 13: DA Cell Geometry Illustration**

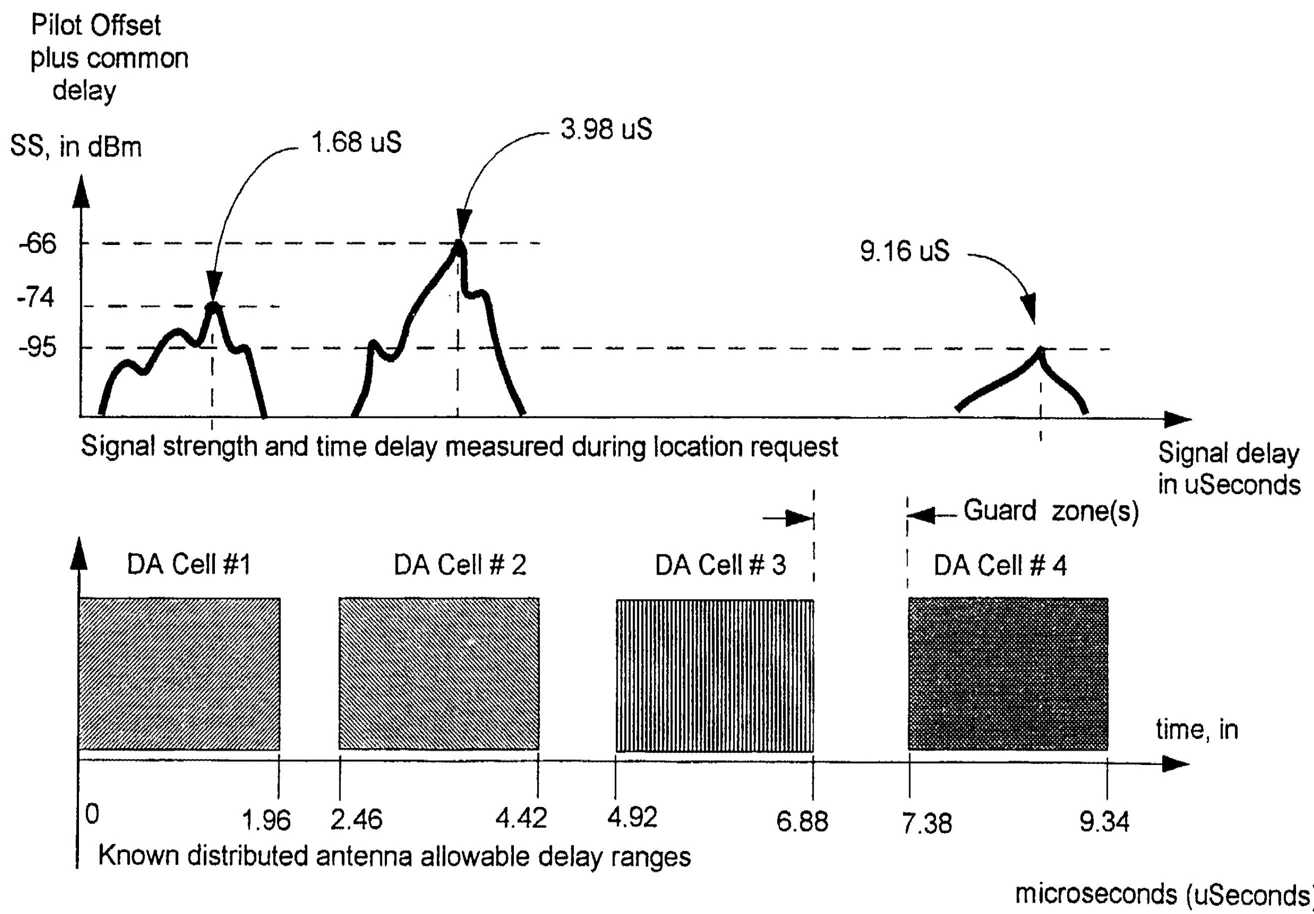



FIG. 14: LOCATION MEASUREMENTS ILLUSTRATION

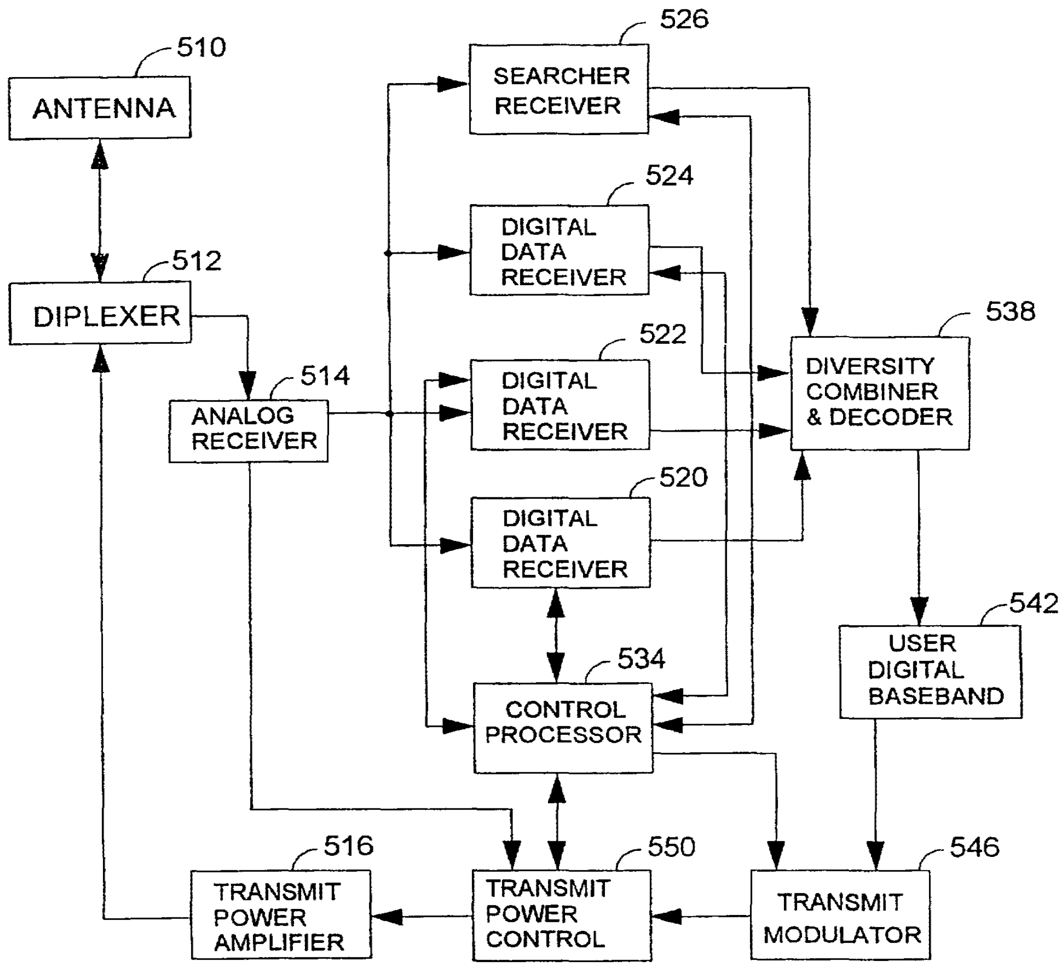



FIG. 15: CDMA Mobile Station Prior Art

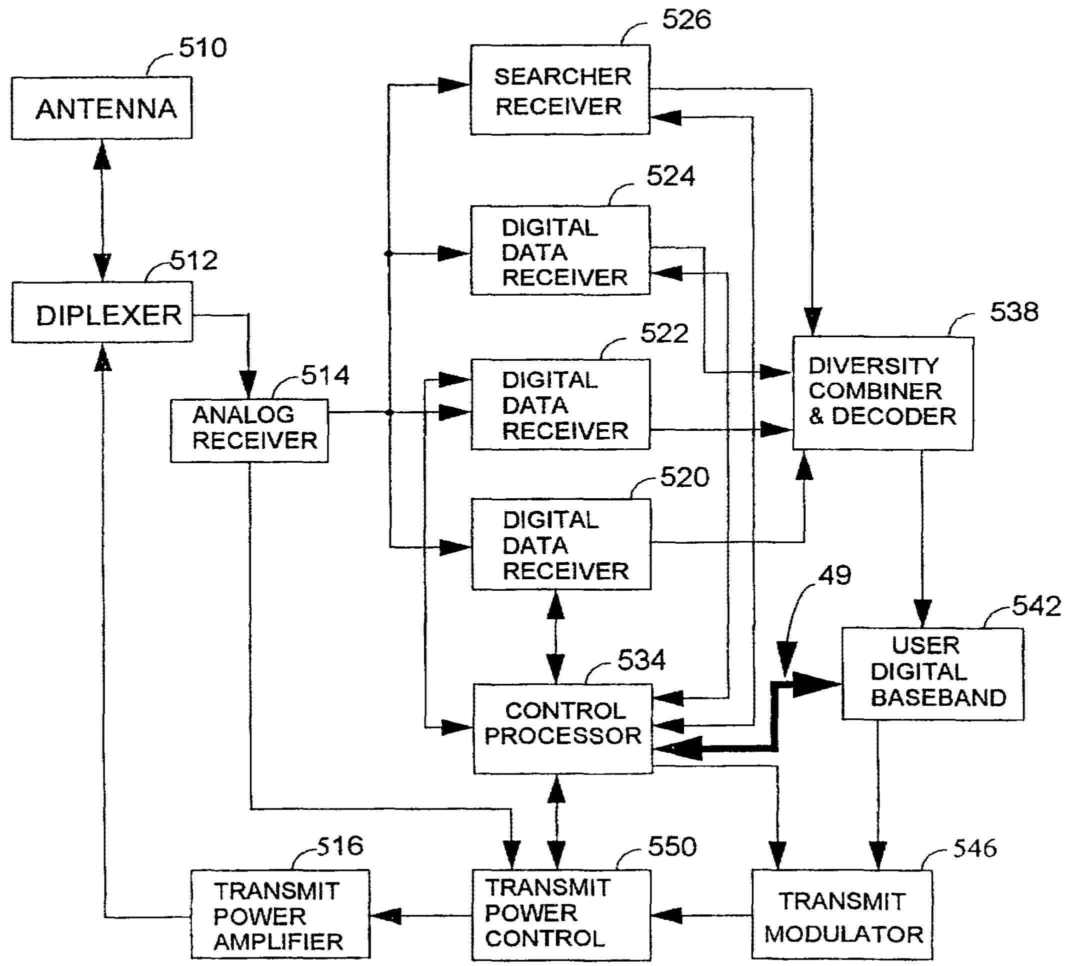



FIG. 16: MS Modification for RF Signal Telemetry

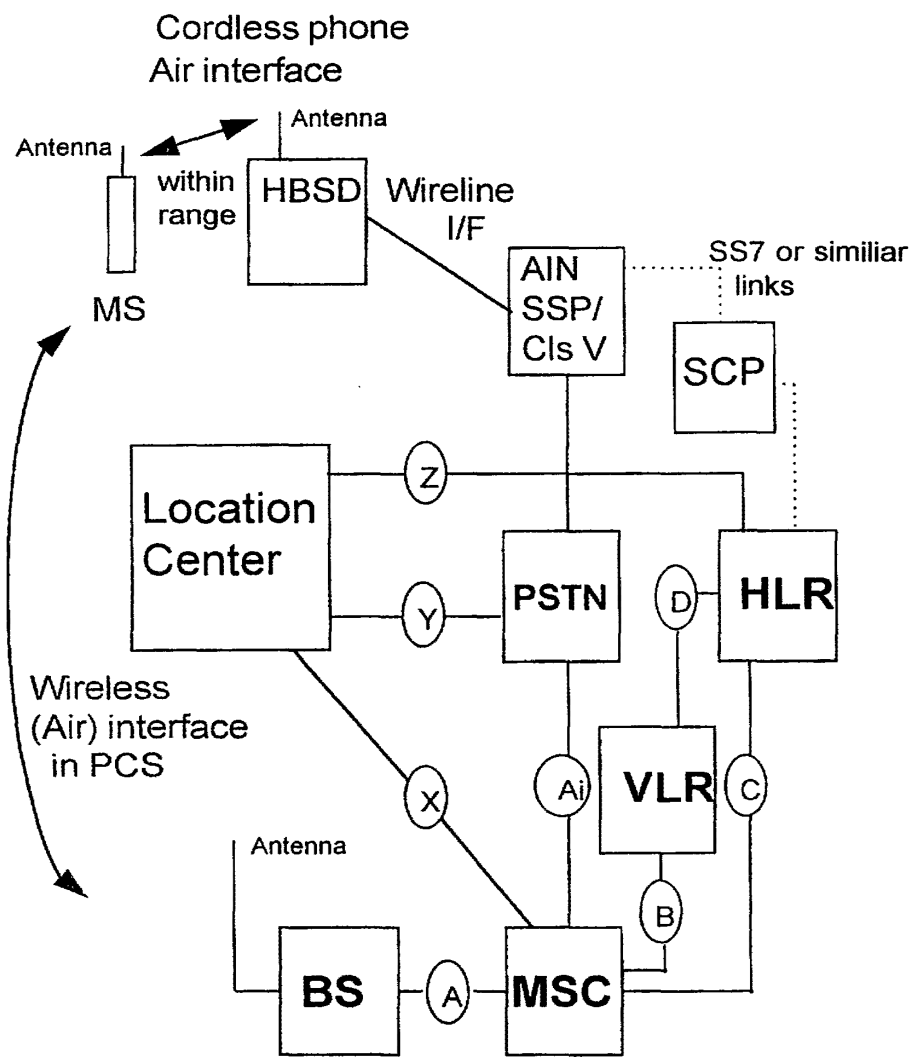



Figure 17: Location and a Home Base Station

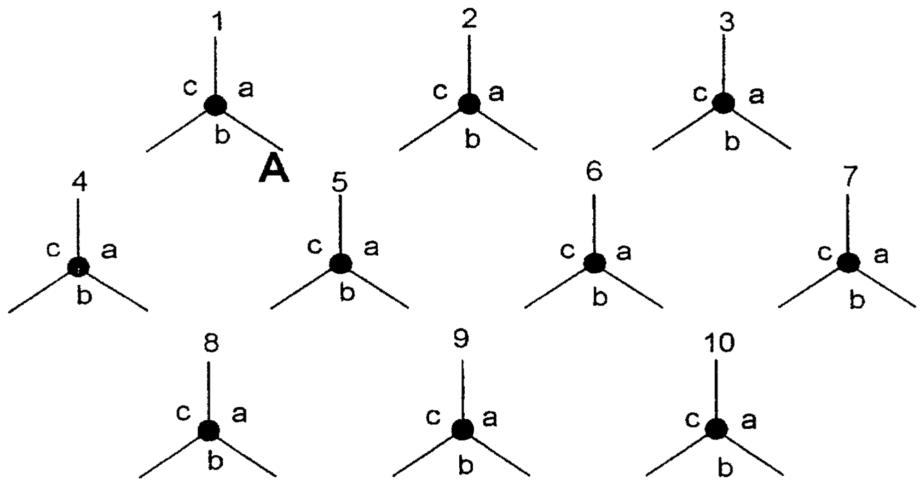



**Fig. 18: MS at location A, detects BSs 1b, 5c and 4a**

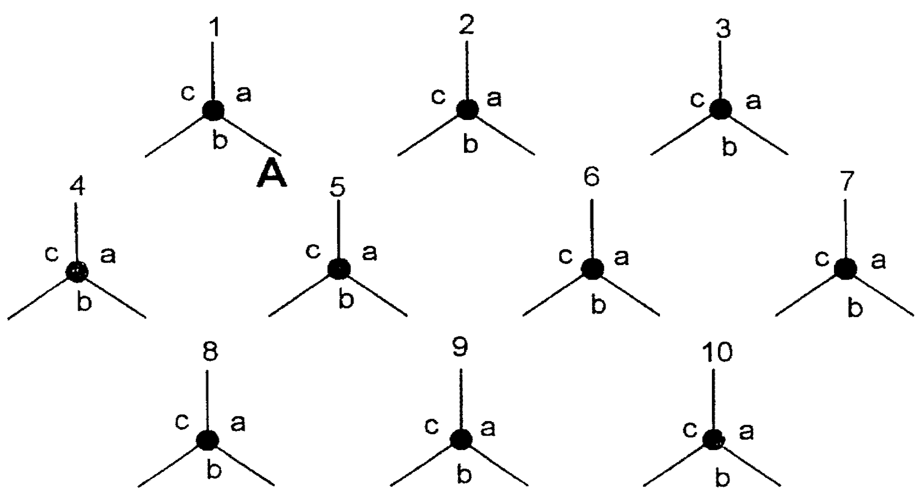



**Fig. 19: MS at location A, detects BSs 1b, 5c, 2c and 4a**

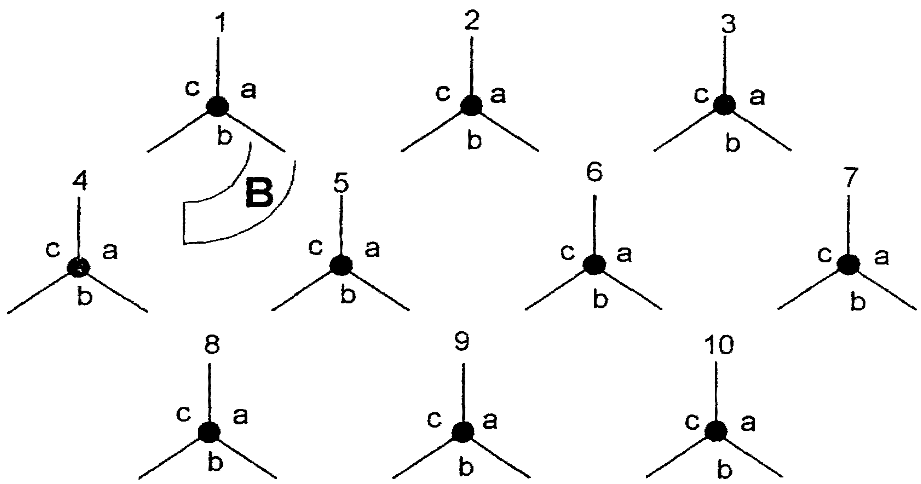



Fig. 20: MS at location B, detects BSs 1b and 2a

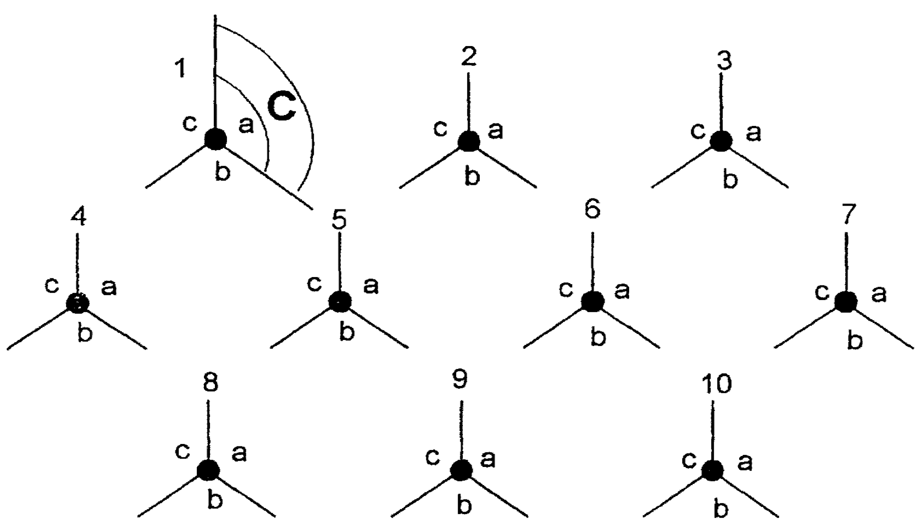



Fig. 21: MS at location C, detects only BS 1a

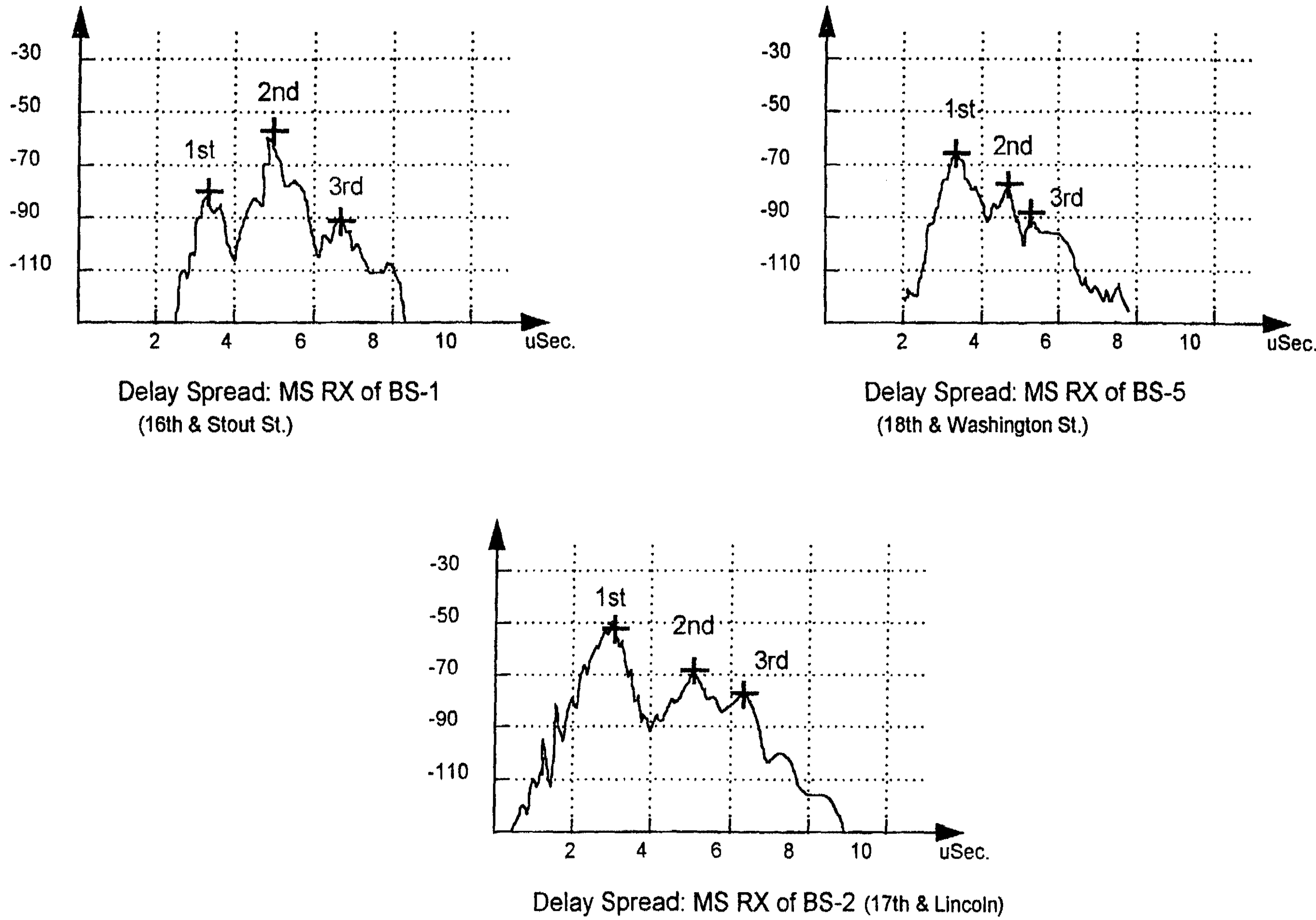
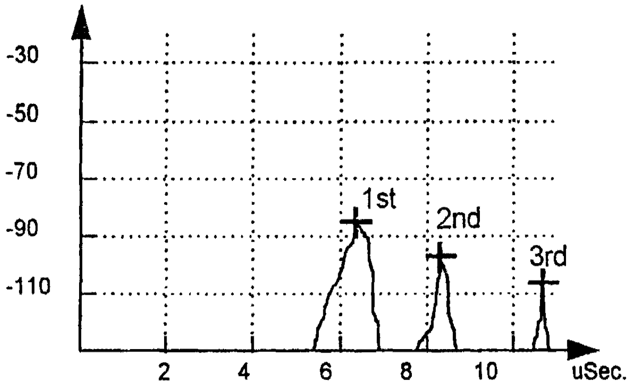
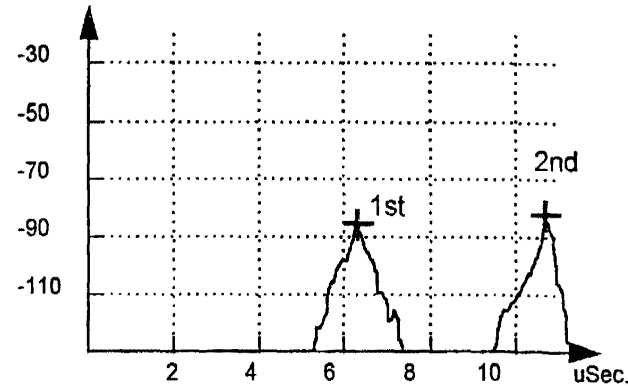


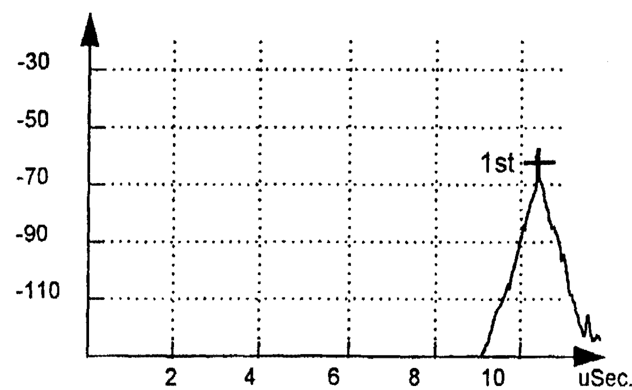

Figure 22: MS Received Delay Spreads of 3 Base Stations (Dense Urban Canyon)




Delay Spread: MS RX of BS-151
(South Table Mesa C.O.)




Delay Spread: MS RX of BS-152
(GC Miining Tower)




Delay Spread: MS RX of BS-154 (Hwy 91 & Rocky Flats)

**Figure 23: MS Received Delay Spreads of 3 Base Stations (Rural Setting)**

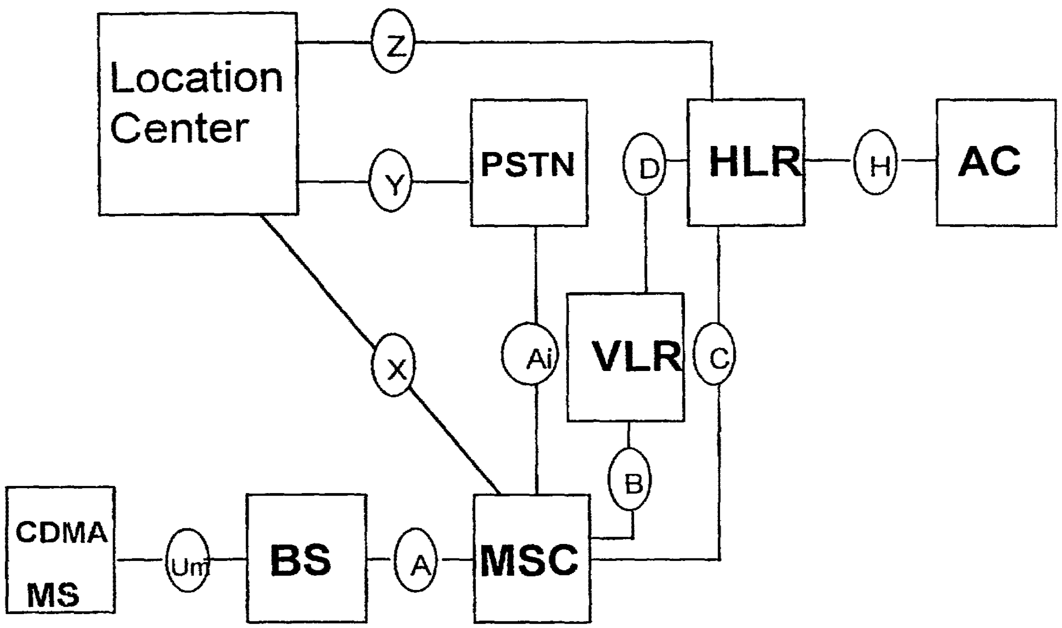



Figure 24: Location and CTIA/TR45 Network Reference Model

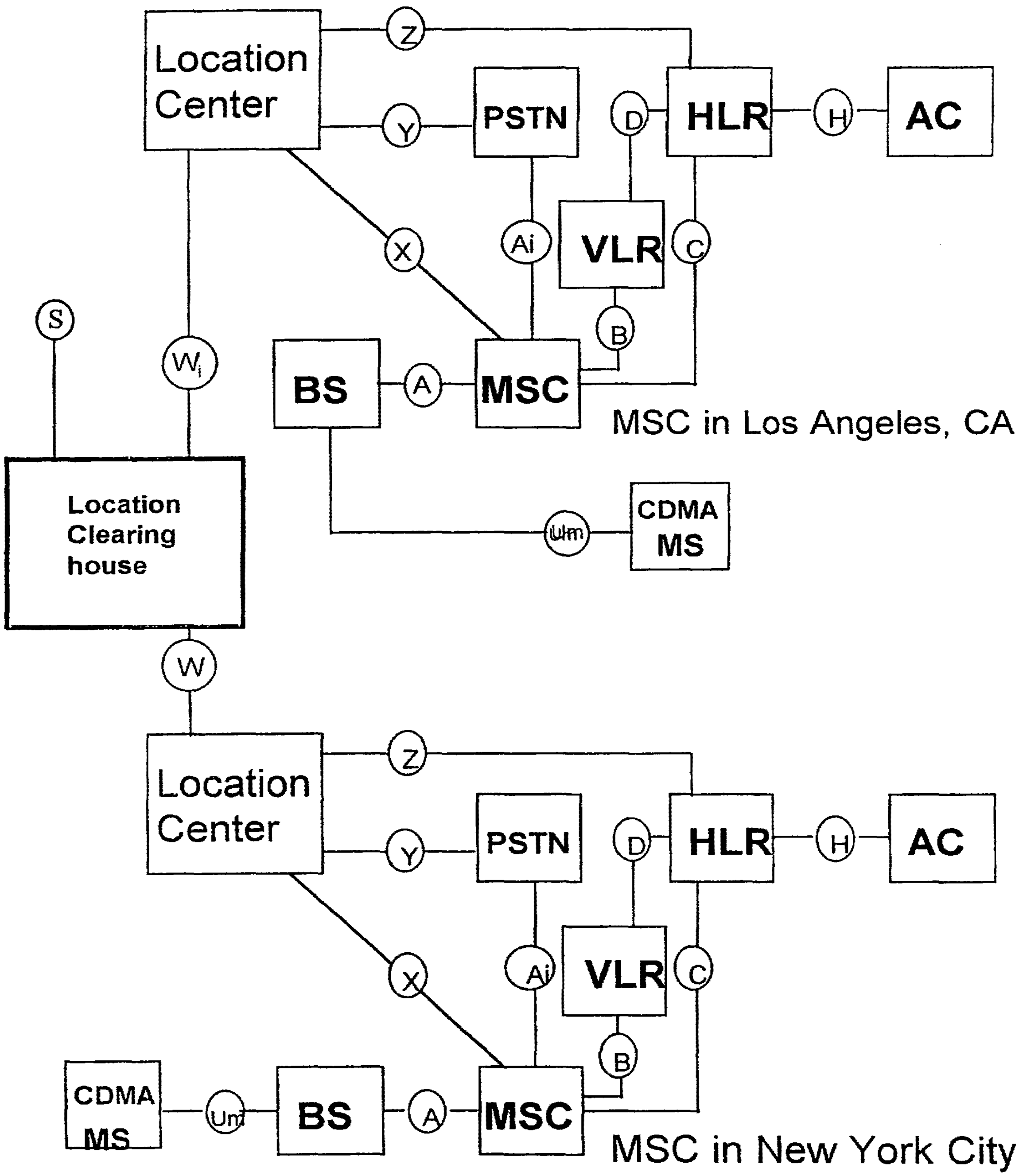



Figure 25: National Location Clearinghouse Structure

/- /95

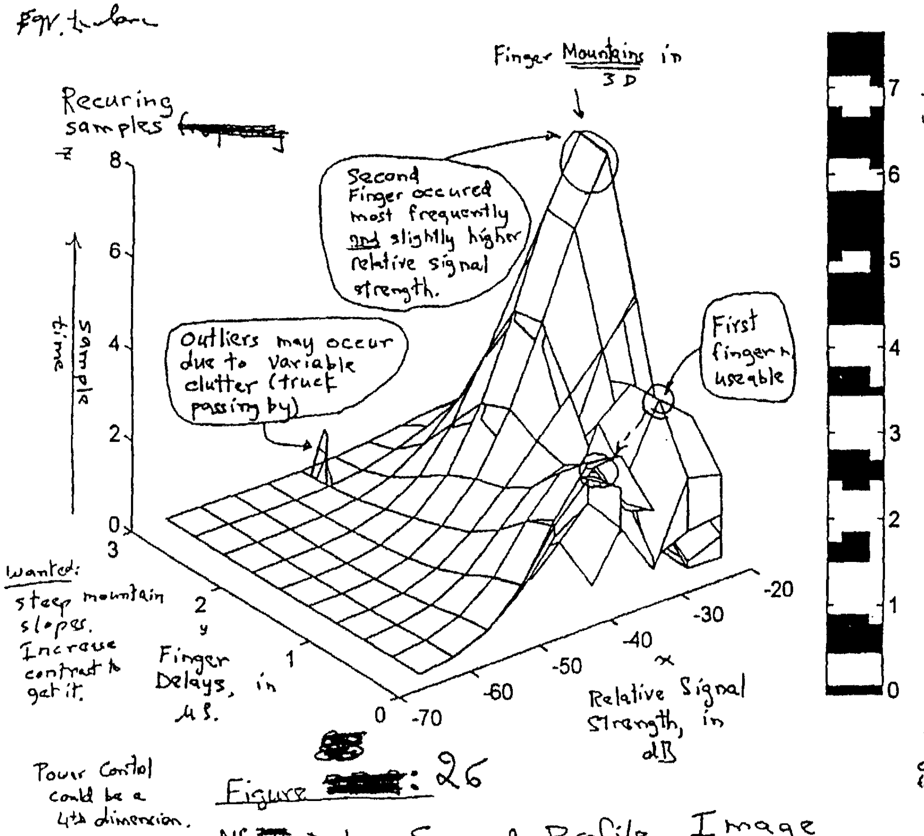


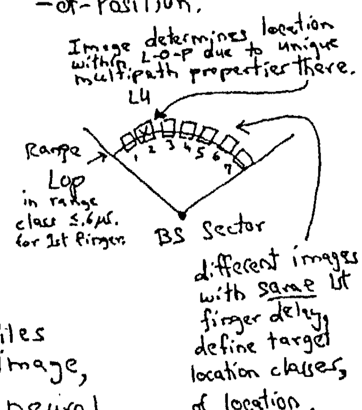

Figure: 26

MS Delay Spread Profile Image

Repeated samples of CDMA Delay Spread Profiles creates a histogram along the z-axis, or 3-D image, providing a more reliable input matrix to a neural net. Various image restoration techniques such as median filtering, can be used to remove outliers (extreme, infrequent values) via sliding neighborhoods.

Location estimate with just one BS:

First finger provides general best range estimate, but entire image surface can provide further information to reduce other ambiguities such as determining a cartesian location along a ranging Line-of-Position.



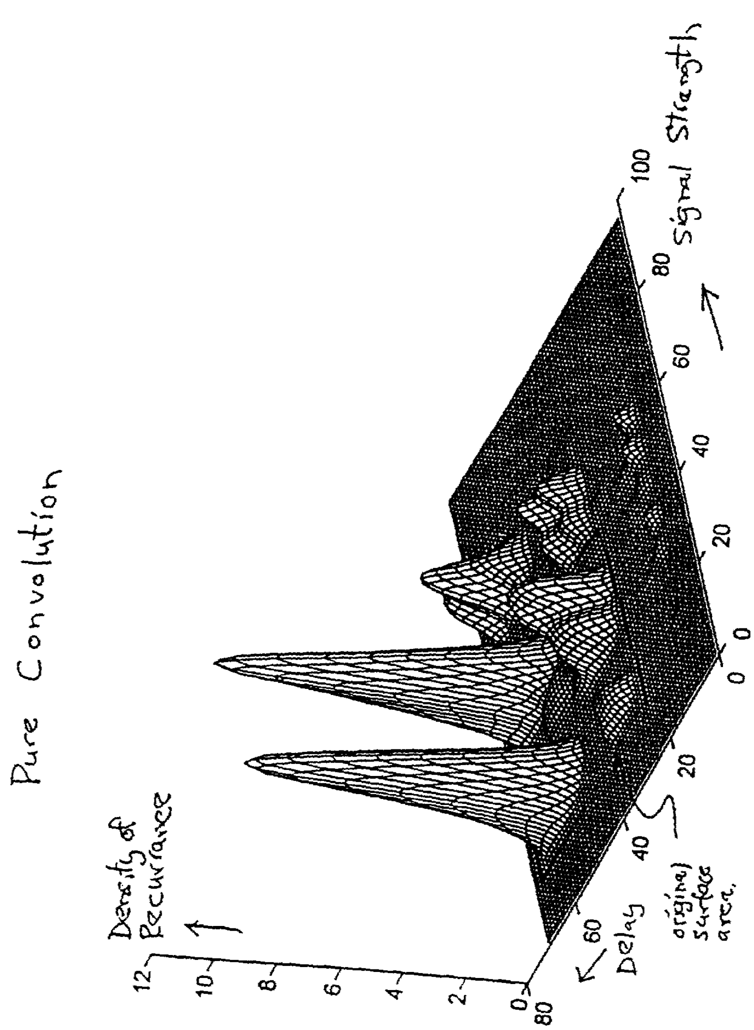



Figure 27: Convolution of Forward and Reverse Images

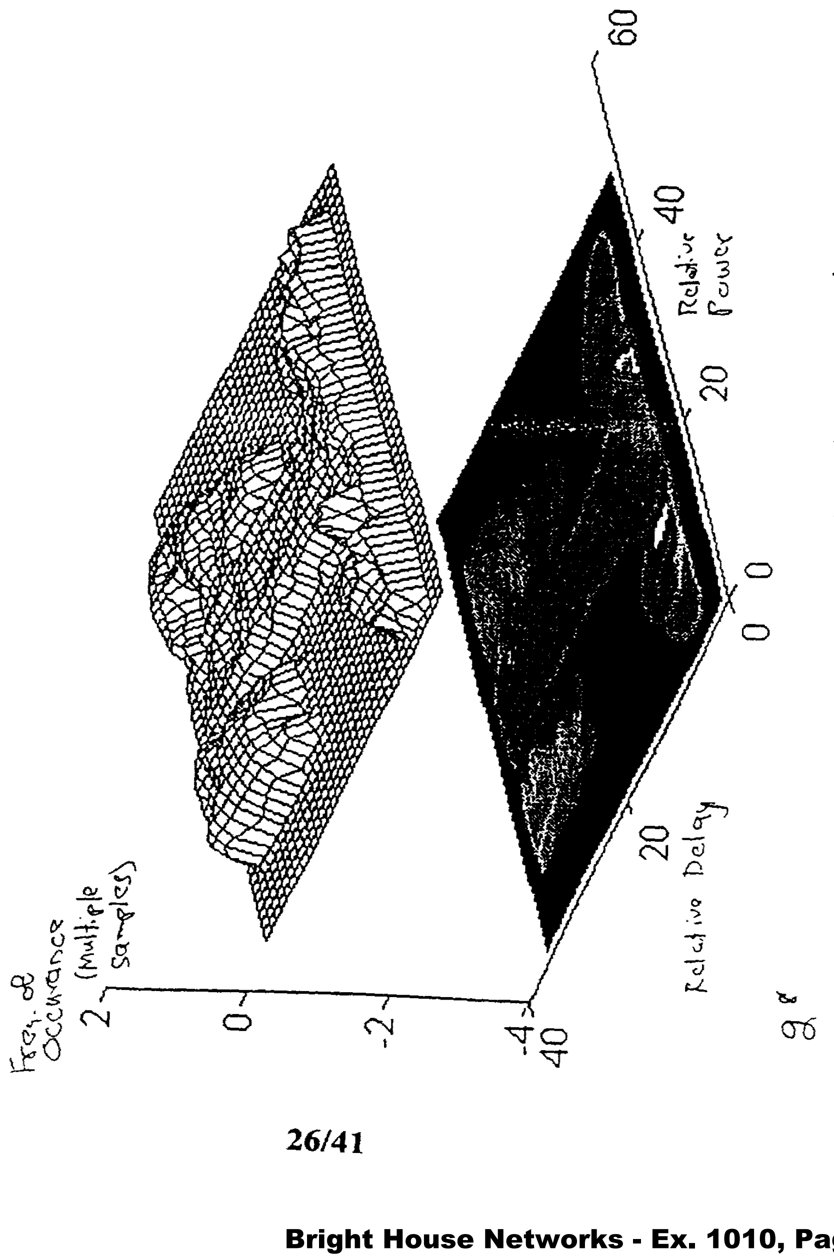



Figure 9 [redacted] : Image and Relief Representation of a CDMA Delay Spread Profile

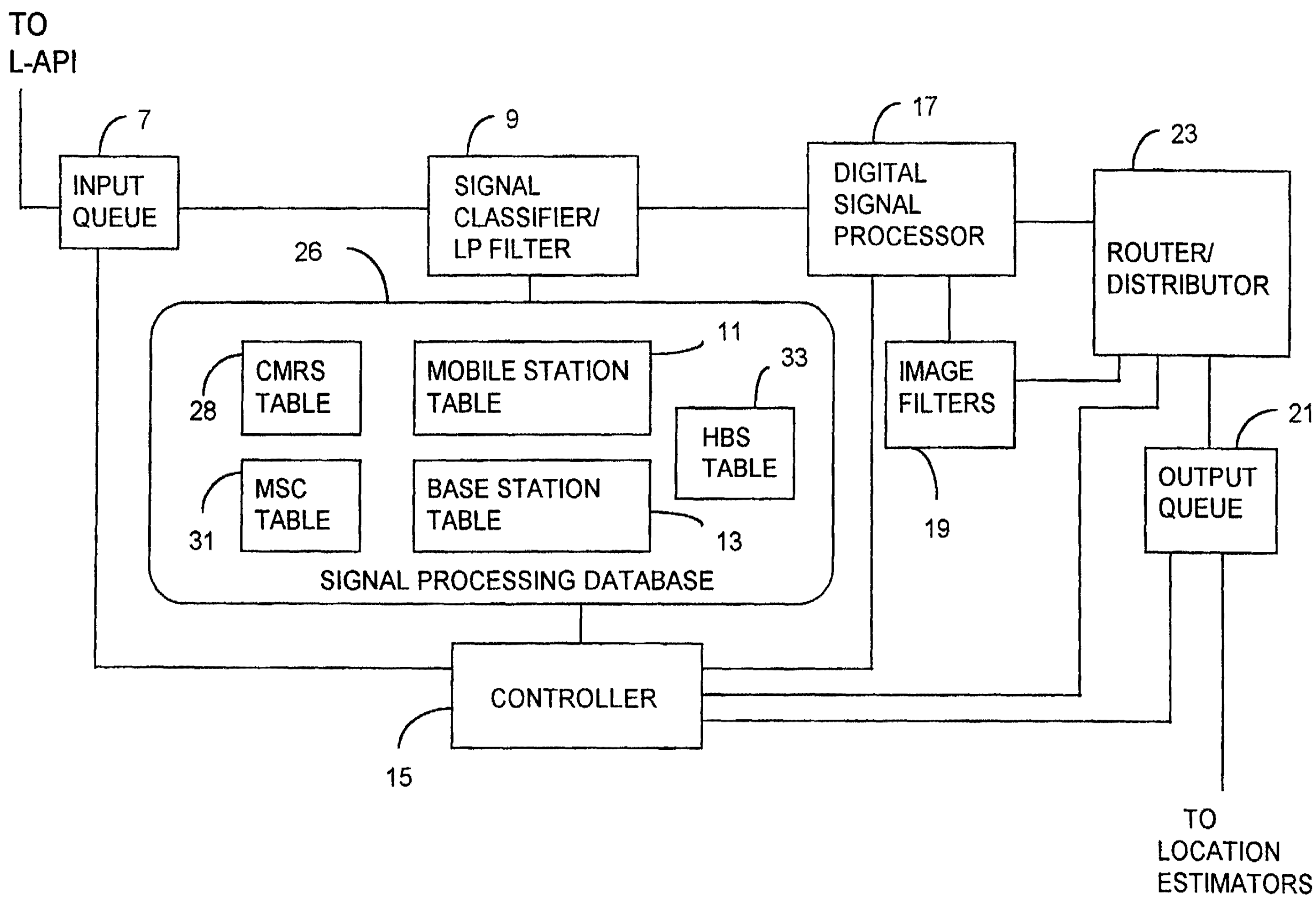



Fig. 29: Signal Processing Subsystem

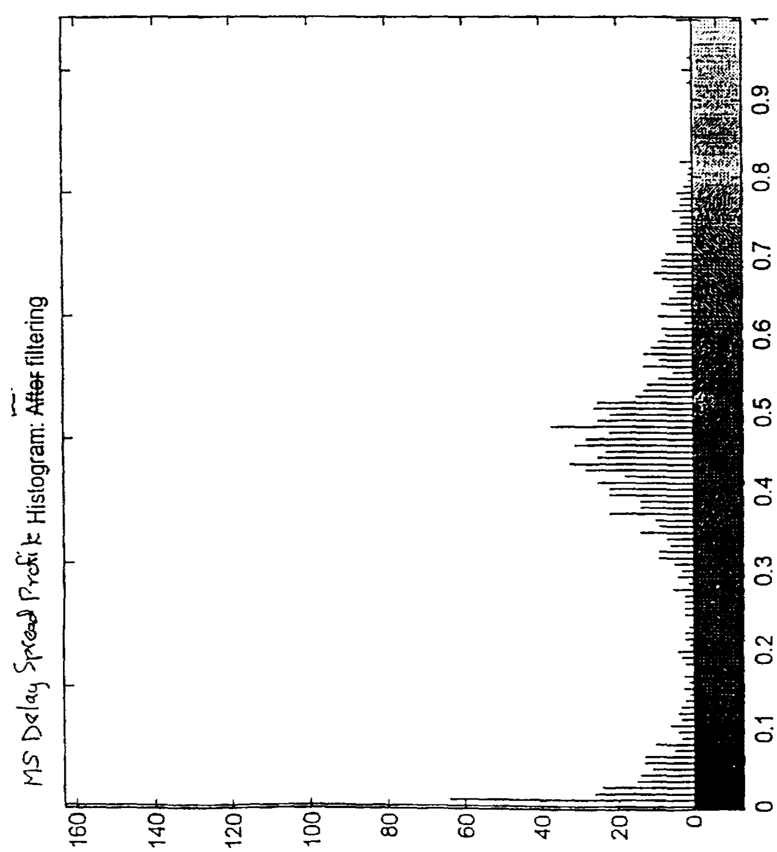



Figure 30: Image Sample Before Histogram Equalization

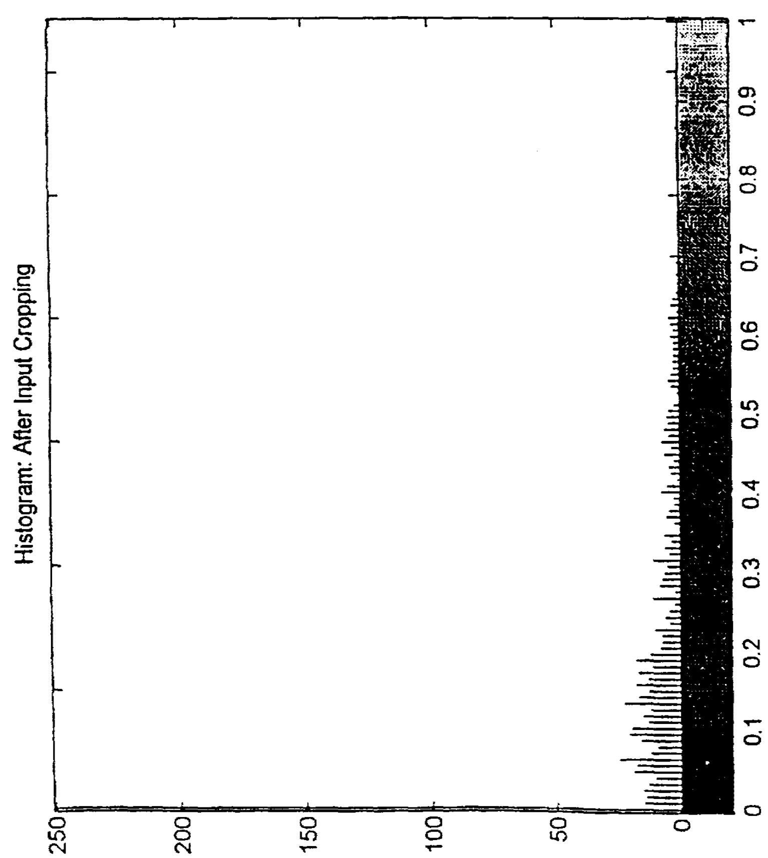



Figure 31: Image Sample After Equalization and Input Cropping

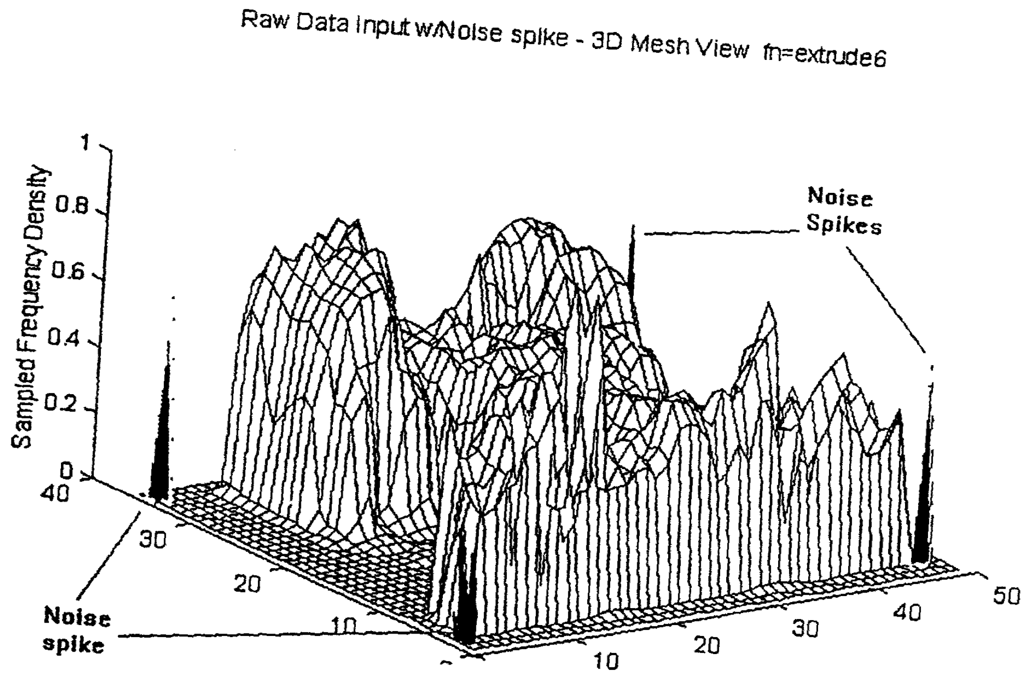
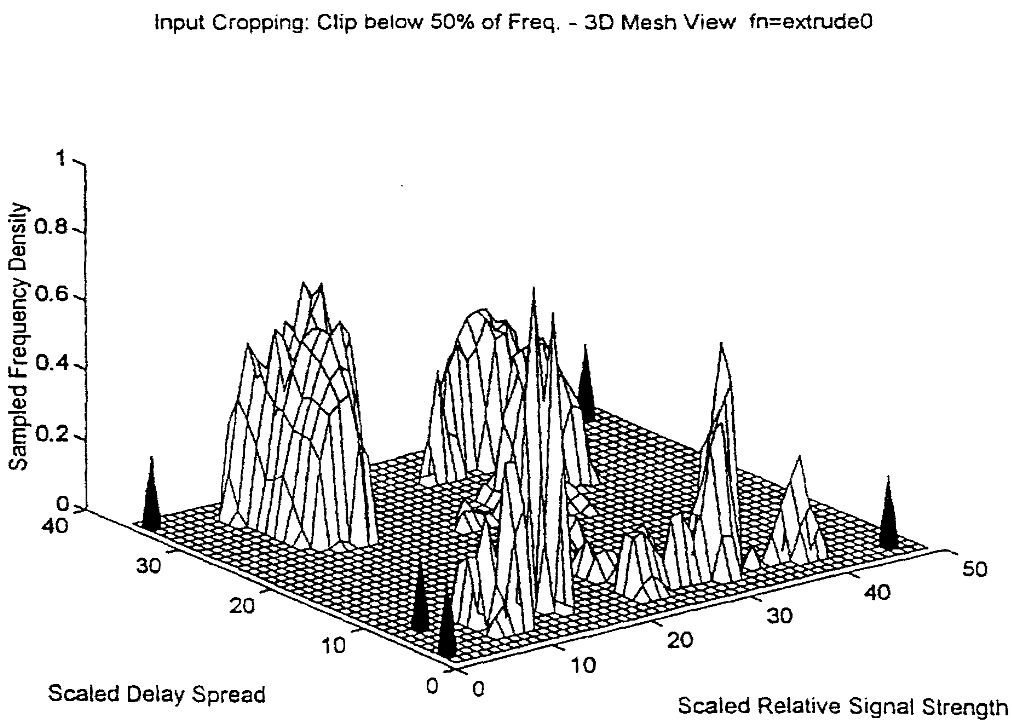


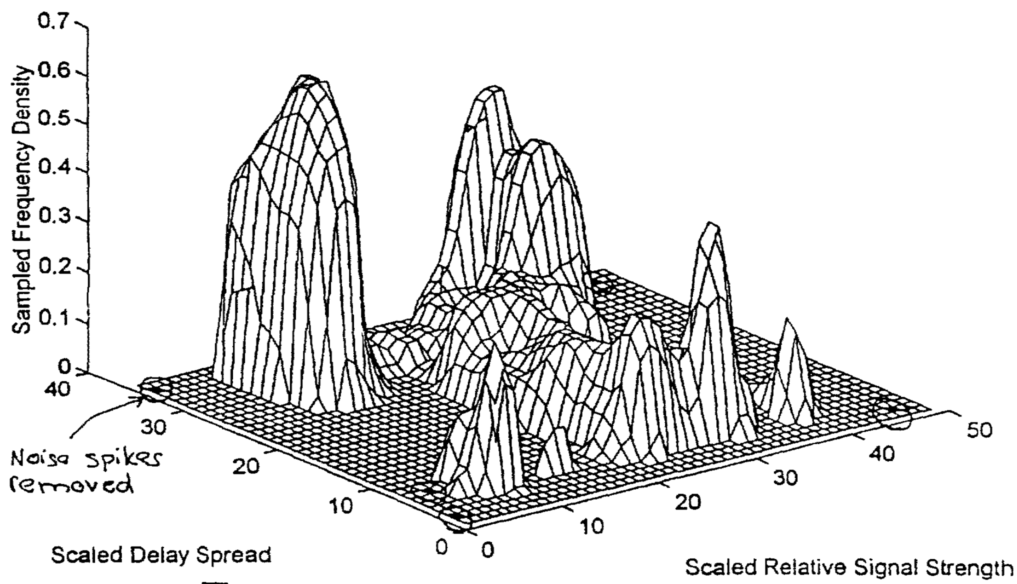

**FIG. 32: CDMA Profile Image Before Filtering**




33

Figure [redacted]: CDMA Profile Image After Input Cropping

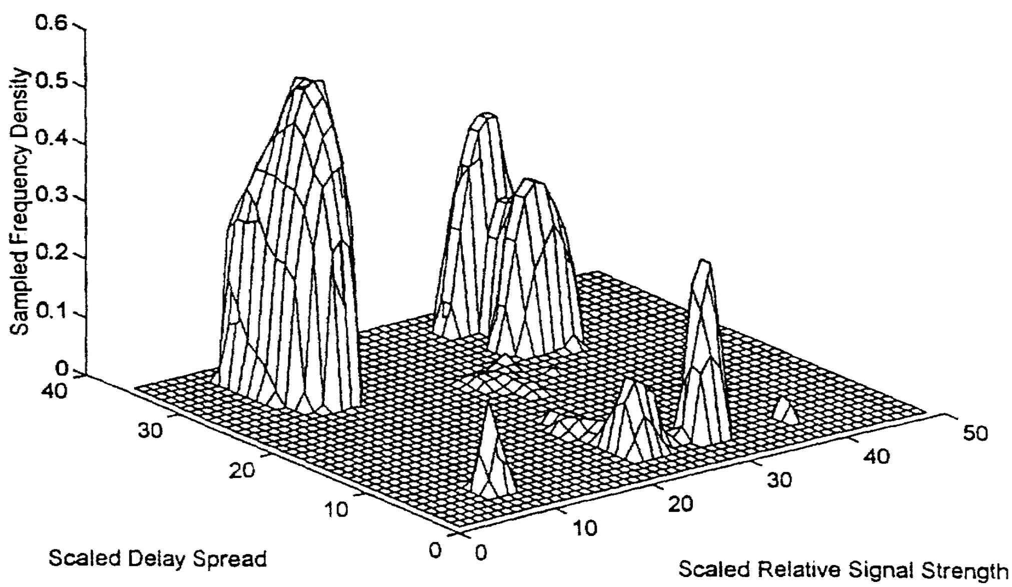
Input Cropping & Median Filter: .4 Clip & 4x4 Neighbors-3D Mesh View fn=extrude5




34

Figure [redacted]: Results of Combining Input Cropping (40%) with Median Filtering (4X4)

Input Cropping & Median Filter: .5 Clip & 4x4 Neighbors-3D Mesh View fn=extrude8




35

Figure [redacted]: Results of Combining Input Cropping (50% clip) with Median Filtering (4x4)

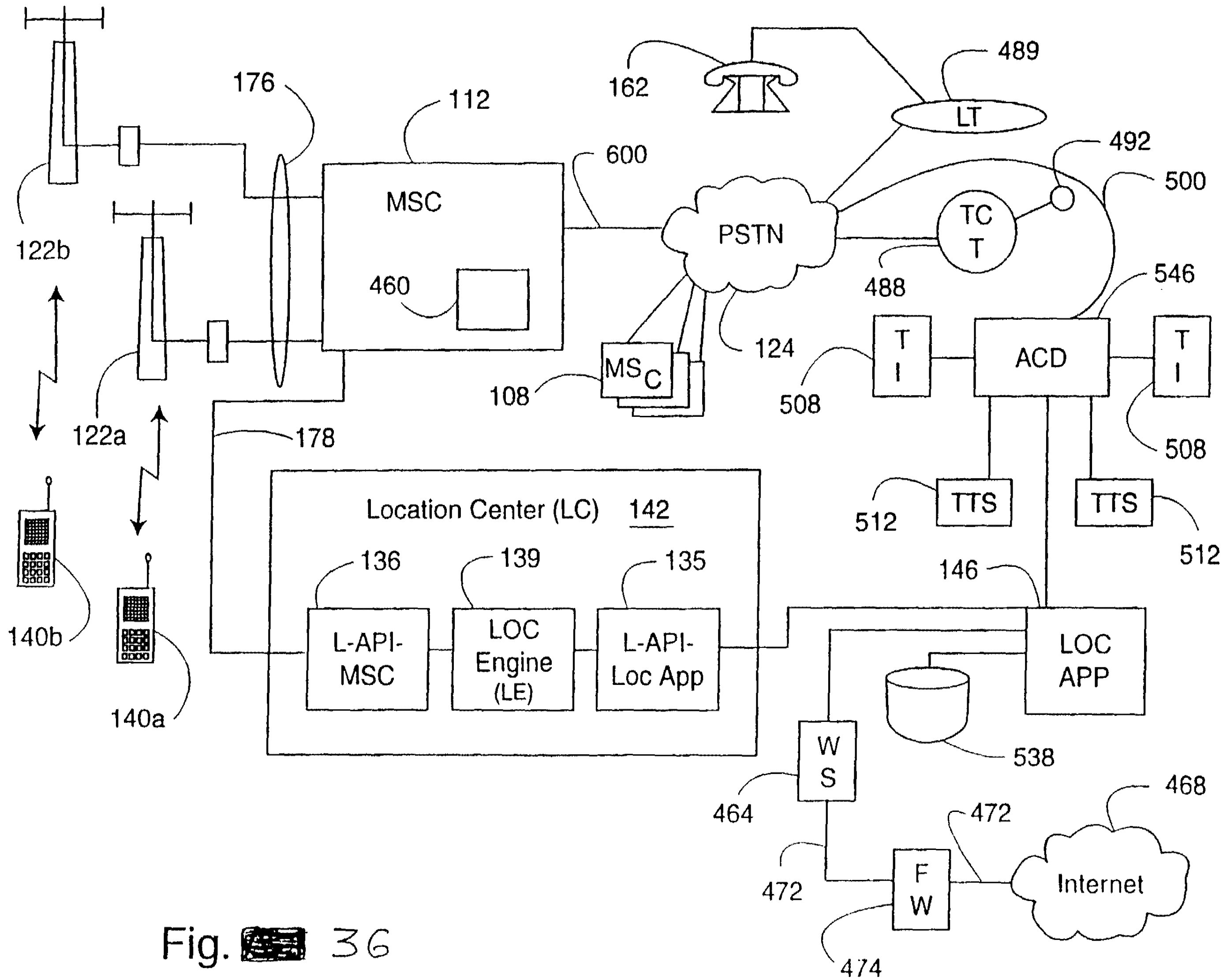



Fig. [redacted] 36

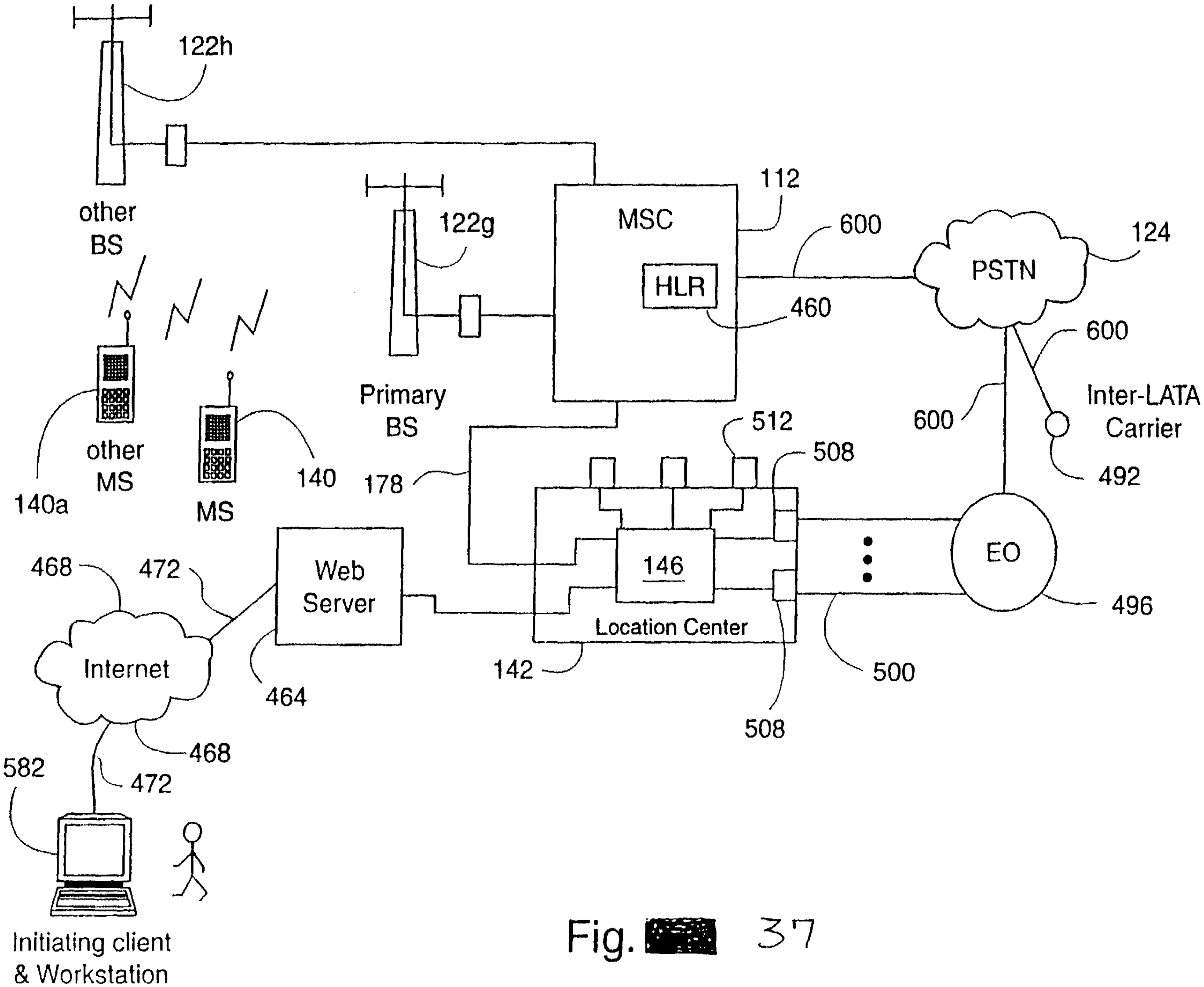



Fig. [redacted] 37

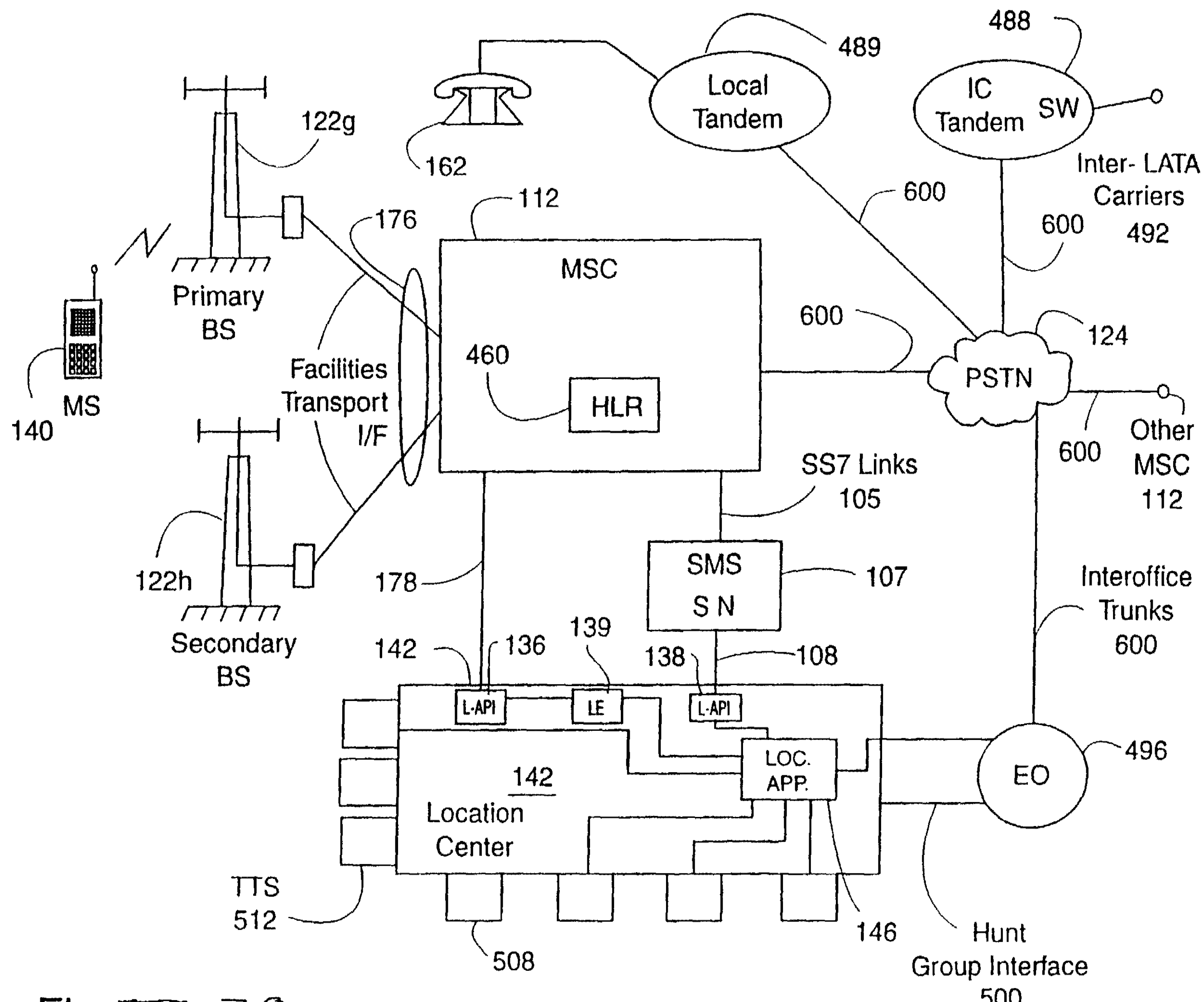



Fig. [redacted] 38

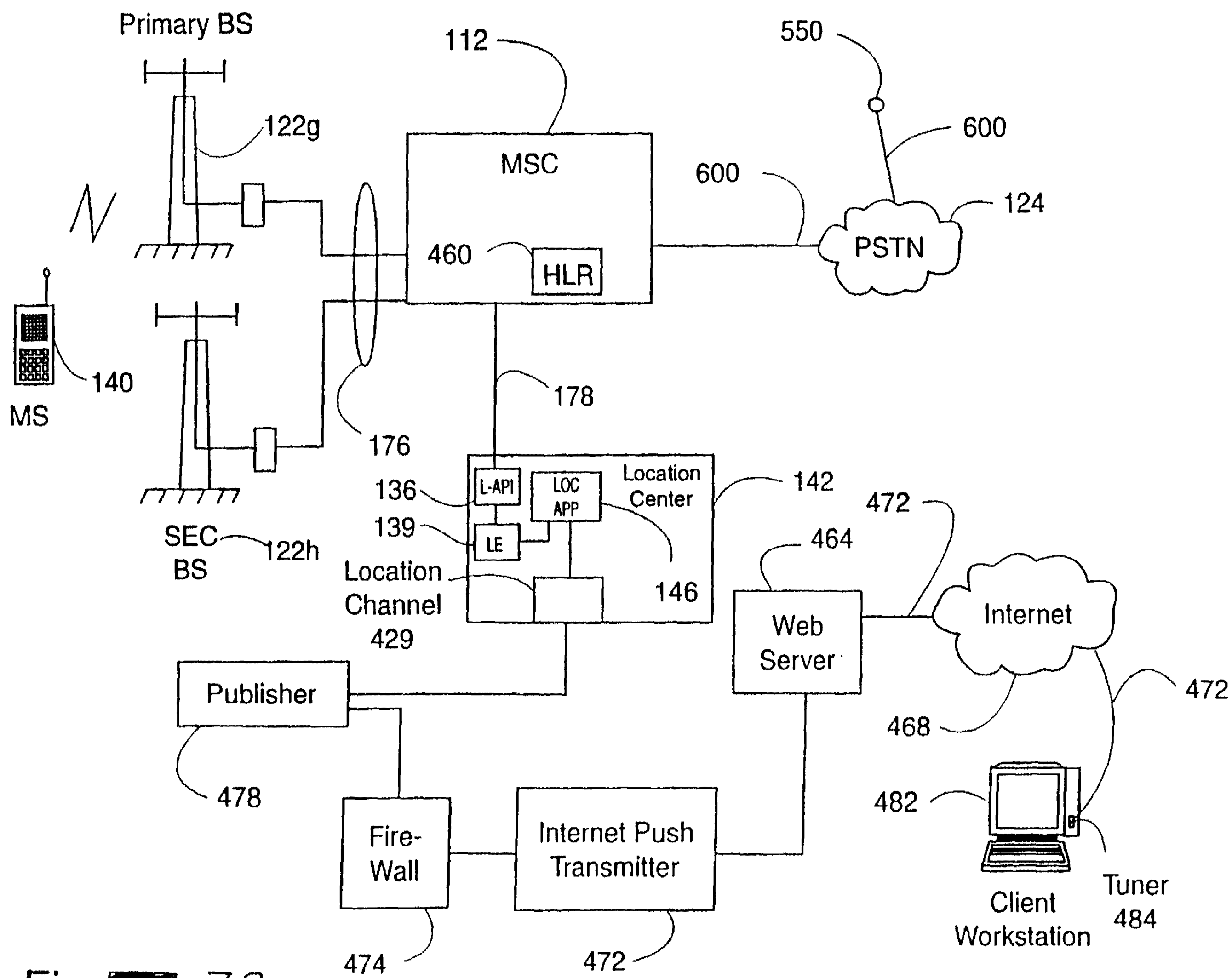



Fig. [redacted] 39

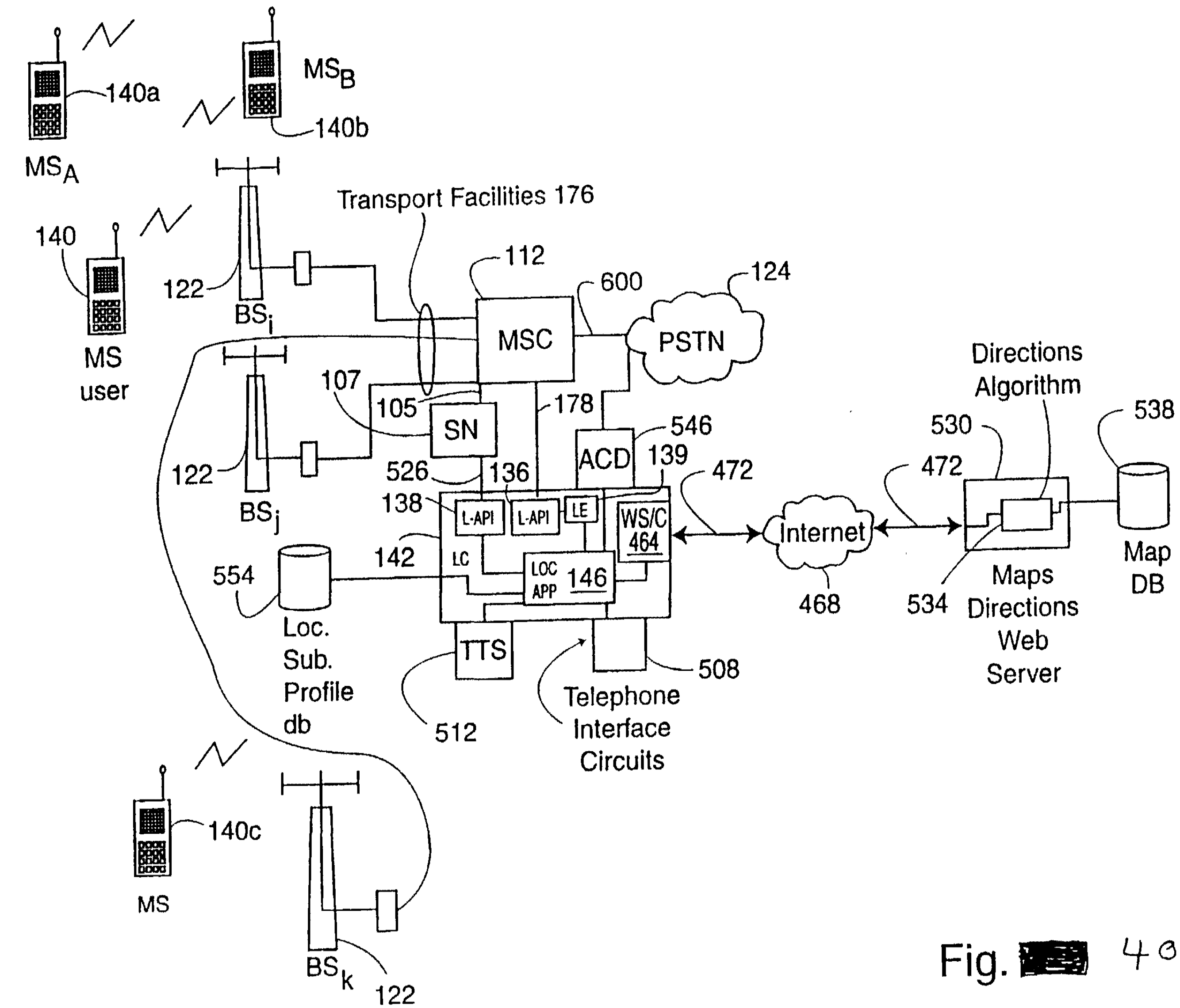



Fig. [redacted] 40

560 564 568

| Turn # | Directions | And Go | Total Miles | |
|---|---|---|---|---|
| Start | Head SOUTH on BROADWAY, From **Start Marker (1999 Broadway, Denver)** | 1.4 mi | 1.4 | |
| 1 | BEAR LEFT onto E. SPEER BLVD | 0.9 mi | 2.4 | |
| 2 | BEAR RIGHT onto S. DOWNING ST | 0.4 mi | 2.8 | **Replace this column with detailed maps for all turns** |
| 3 | TURN RIGHT onto E. CEDAR AV | 0.1 mi | 2.8 | |
| 4 | TURN LEFT onto S. MARION PKY | And then | 2.9 | |
| END | **End Marker (255 marion Parkway, Denver, CO)** | | 2.9 | |

**WARNING:** use these directions at your own risk. Lucent Technologies is not responsible for their accuracy or for any losses resulting from their use. **Obey all traffic regulations.**

**User Manual Sections:** [Routes In General] [Turn-By-Turn Directions] [Caveats]

Fig. [redacted] 41

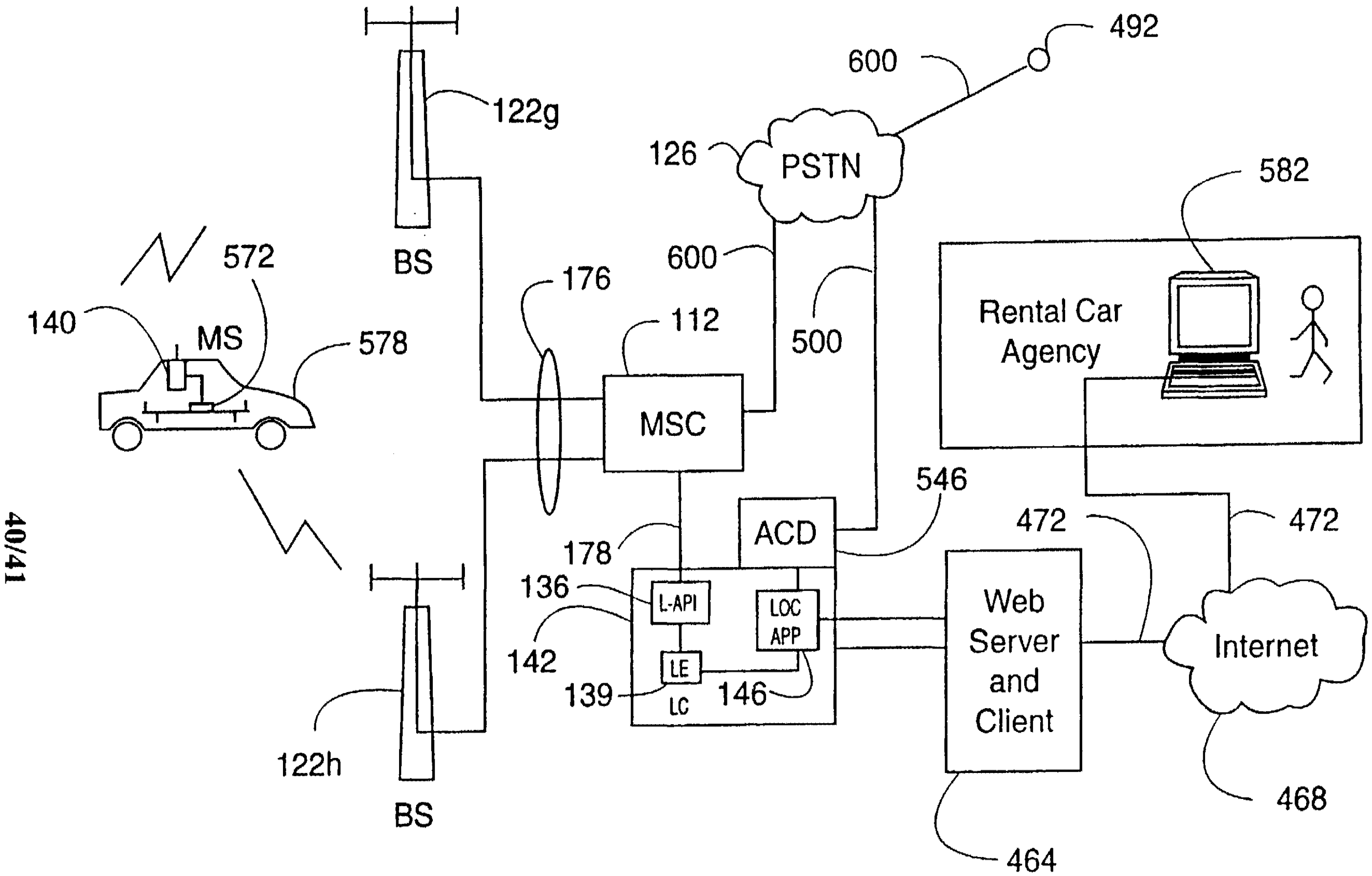



Fig. [redacted] 42

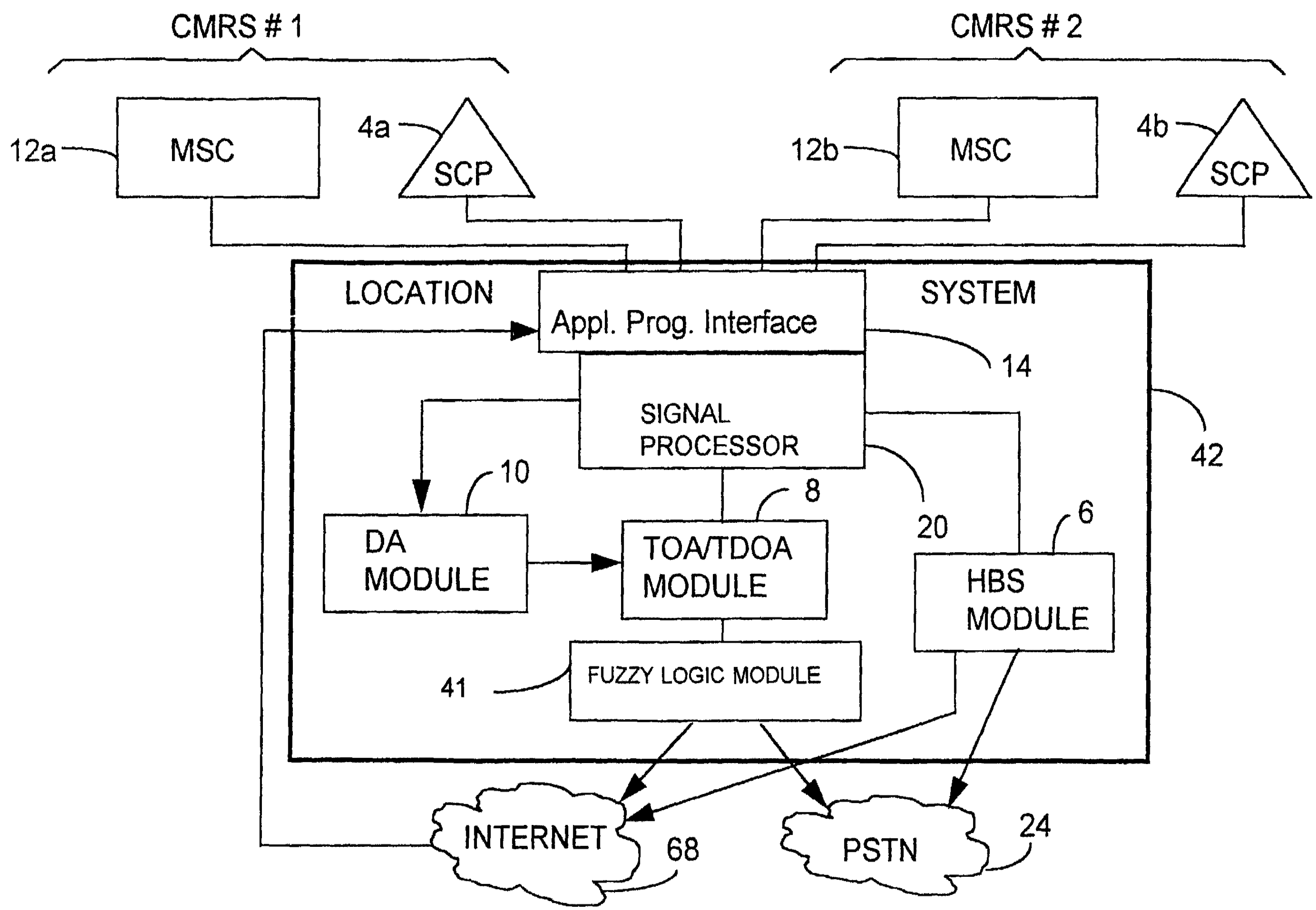



FIG. 43: WIRELESS LOCATION USING FUZZY LOGIC

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/15933

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC(6) :Please See Extra Sheet.
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 5,390,339 A (BRUCKERT ET AL.) 14 February 1995, col. 2, lines 38-48, col. 4, lines 51-60, col. 7, lines 32-47, col. 10, line 54 through col. 11, line 28, abstract lines 3-15 and Fig.2A. | 1-12, 48-63, 77-81, 91-94 |
| X | US 5,485,163 A (SINGER ET AL.) 16 January 1996, col. 1, lines 49-55, col. 2, lines 44-67, col. 3, lines 9-16 and 65-67, col. 4, lines 4-25, col. 5, lines 1-8 and 14-36. | 13-22, 31-47, 52-63, 77-81, 88-90 |
| X,P | US 5,619,552 A (KARPPANEN ET AL.) 08 April 1997, col. 2, lines 4-10, col 3. lines 5-10, col. 4, lines 52-55. | 13-22 |
| X | US 5,293,645 A (SOOD) 08 March 1994, Fig. 1 and col. 2, lines 50-58. | 23-30, 87 |

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

| | | | |
|---|---|---|---|
| * | Special categories of cited documents: | "T" | later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention |
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| "E" | earlier document published on or after the international filing date | "Y" | document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| "L" | document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) | "&" | document member of the same patent family |
| "O" | document referring to an oral disclosure, use, exhibition or other means | | |
| "P" | document published prior to the international filing date but later than the priority date claimed | | |

Date of the actual completion of the international search
07 DECEMBER 1997

Date of mailing of the international search report
03 FEB 1998

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
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Facsimile No. (703) 305-3230

Authorized officer
Lester Kincaid
Telephone No. (703) 305-3900

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/15933

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X | US 5,218,716 A (COMROE ET AL.) 08 June 1993, Fig. 2, blocks 201-206. | 31-47 |
| X | US 5,519,760 A (BORKOWSKI ET AL.) 21 May 1996, col. 8, lines 22-39. | 41-47 |
| X,P | US 5,564,079 A (OLSSON) 08 October 1996, col. 2, lines 58-67, col. 3, lines 10-52. | 64-76, 87 |
| X,P | US 5,570,412 A (LEBLANC) 29 October 1996, col. 10, lines 52-61, col. 16, lines 47-59, col. 17, lines 12-47, col. 25, lines 6-40. | 82-86, 88-90 |
| A | US 5,490,204 A (GULLEDGE) 06 February 1996, col. 2, lines 8-10 and Abstract lines 14-27. | 1, 31, 41 |
| A | US 5,513,246 A (JONSSON ET AL.) 30 April 1996, col. 10, lines 43-55. | 1-6, 12 |
| A,P | US 5,561,840 A (ALVESALO ET AL.) 01 October 1996, col. 2, lines 62-66, col. 3, lines 5-26, col. 4,lines 55-66 | 13-22 |
| A | US 5,548,835 A (SASAKI) 20 August 1996, Fig.3. | 23-30 |
| A,P | US 5,621,414 A (NAKAGAWA) 15 April 1997, Fig. 1. | 23-30 |
| A | US 5,329,576 A (HANDFORTH) 12 July 1994, Fig.1. | 23-30 |
| A | US 5,355,511 A (HATANO et al.) 11 October 1994, Abstract. | 31 |
| A | US 5,357,561 A (GRUBE) 18 October 1994, Abstract. | 31 |
| A | US 5,481,588 A (RICKLI et al.) 02 January 1996, Fig.1 and Abstract. | 64-76 |
| A | US 5,465,390 A (COHEN) 07 November 1995, Fig. 2. | 64-76 |
| A | US 5,293,642 A (LO) 08 March 1994, Abstract. | 41-47, 82-86 |
| A | US 5,390,124 A (KYRTSOS) 14 February 1995, Abstract. | 82-86 |
| A | US 5,539,810 A (KENNEDY, III ET AL.) 23 July 1996, Fig. 1. | 31 |
| A | US 5,432,841 A (RIMER) 11 July 1995, Fig. 2 and Abstract, lines 1-5. | 31 |

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/15933

**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [ ] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. [ ] Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. [X] As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. [ ] No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

[ ] The additional search fees were accompanied by the applicant's protest.
[X] No protest accompanied the payment of additional search fees.

A. CLASSIFICATION OF SUBJECT MATTER:
IPC (6):

H04B 7/26, 17/00; H04Q 7/20, 7/22, 7/24, 7/26; G01S 3/02; H04M 11/00

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

455/426, 432, 433, 435, 466, 14, 15, 521, 524; 342/451, 457; 364/449.1, 449.8

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

455/426, 432, 433, 435, 466, 14, 15, 521, 524, 404, 411, 414, 421, 422, 434, 457, 437, 16, 17, 517, 560; 342/357, 451, 457; 364/449.1, 449.8, 449.7, 449.3

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1. In order for all inventions to be searched, the appropriate additional search fees must be paid.

Group I, claim(s) 1-12, 48-51 and 91-94, drawn to locating a mobile station by measuring forward and reverse signals.

Group II, claim(s) 13-22, drawn to locating a mobile station by accessing a predetermined storage location representative of a status change.

Group III, claim(s) 23-30 and 87, drawn to locating a mobile station by measuring a plurality of signal time delay measurements with a system of antennas connected in series and having a predetermined delay between each antenna.

Group IV, claim(s) 31-40, drawn to locating a mobile station by instructing the mobile to search for a signal from a different network.

Group V, claim(s) 41-47, drawn to activating the location estimator a second time if the first estimate does not exist.

Group VI, claim(s) 52-63 and 77-81, drawn to locating a mobile station by measuring pairs of signal strength values and corresponding time delay values.

Group VII, claim(s) 64-76, drawn to obtaining data related to wireless signal characteristics by driving a test mobile over a predetermined route.

Group VIII, claim(s) 82-86, drawn to locating a mobile by categorizing and filtering measured data.

Group IX, claim(s) 88-90, drawn to tracking permission to receive location data.

The inventions listed as Groups I-IX do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature unique to each group, as identified above, enable nine separate independent inventions capable of use without the inventions of the other groups.

PCT

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International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04B 7/26, 17/00, H04Q 7/20, 7/22, 7/24, 7/26, G01S 3/02, H04M 11/00 A1

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(21) International Application Number: PCT/US97/15933

(22) International Filing Date: 8 September 1997 (08.09.97)

(30) Priority Data:

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| 60/044,821 | 25 April 1997 (25.04.97) | US |
| Not furnished | 20 August 1997 (20.08.97) | US |

(71)(72) Applicants and Inventors: LEBLANC, Frederick, W. [US/US]; 7547 Braun Street, Arvada, CO 80005 (US). DuPRAY, Dennis, Jay [US/US]; 222 South Marion Parkway, Denver, CO 80209 (US). KARR, Charles, L. [US/US]; 400 Sandbrook Lane, Tuscaloosa, AL 35405 (US).

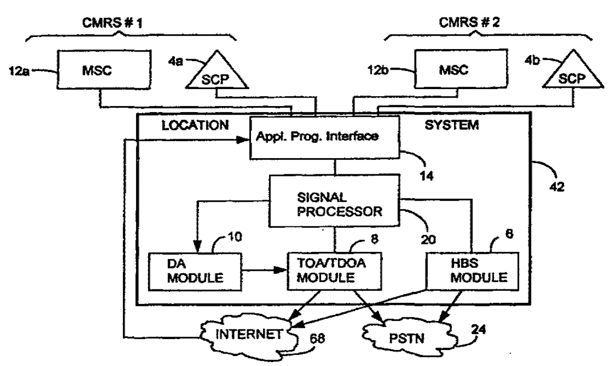
(74) Agents: DuPRAY, Dennis, J. et al.; Sheridan Ross P.C., Suite 3500, 1700 Lincoln Street, Denver, CO 80203-4501 (US).

(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

**Published**
*With international search report.*
*With amended claims.*

Date of publication of the amended claims: 4 June 1998 (04.06.98)

(54) Title: LOCATION OF A MOBILE STATION USING A PLURALITY OF COMMERCIAL WIRELESS INFRASTRUCTURES




WIRELESS LOCATION USING MULTIPLE CMRSs

(57) Abstract

A location system for commercial wireless telecommunication infrastructures (CMRRs). The system is an end-to-end solution having one or more location systems (42) for outputting requested locations of commercially available hand sets or mobile stations (not shown) based on, e.g, AMPS, NAMPS, CDMA or TDMA communication standards, for processing both local mobile station location requests and more global mobile station location requests via, e.g., Internet communication between a distributed network of location systems. The system uses a plurality of mobile station locating technologies including those based on: two-way TOA and TDOA; home base stations and distributed antenna provisioning. Further, the system can be modularly configured for use in location signaling environments ranging from urban, dense urban, suburban, rural, mountain to low traffic or isolated roadways. Accordingly, the system is useful for 911 emergency calls, tracking, routing, people and animal location including applications for confinement to and from certain areas.

*FOR THE PURPOSES OF INFORMATION ONLY*

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

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AMENDED CLAIMS

[received by the International Bureau on 3 April 1998 (03.04.98); original claims 1-94 replaced by amended claims 1-79 (24 pages)]

1. A method for locating a wireless mobile station in an area, wherein the area is included in a first area for a first network, and a second area for a second network, wherein:

the first network has a first collection of one or more base station controllers, wherein each of the base station controllers control communications with a corresponding predetermined plurality of geographically dispersed base stations of the first network, wherein each base station controller of said first collection has access to operating characteristics of mobile stations registered with the first network for subscribing to a first wireless service offered by the first network,

the second network has a second collection of one or more base station controllers, wherein each of the base station controllers in the second collection control communications with a corresponding predetermined plurality of geographically dispersed base stations of the second network, said second collection operably disjoint from said first collection, wherein each base station controller of said second collection has a more restricted access to at least one operating characteristic of mobile stations: (i) registered with the first network, and (ii) not registered with the second network for subscribing to a wireless service offered by the second network,

comprising:

receiving first data related to wireless signals communicated between a particular mobile station in the area and the first network, wherein said particular mobile station is registered with the first network;

first activating first location estimator for providing a first estimate of a location of the mobile station, wherein said first location estimator is supplied with first location information for deriving said first estimate, said first location information at least partially derived from the first data, said location information capable of changing with a change in a location of said particular mobile station;

determining, from at least one of said first location information and said first estimate, a subset of one or more base station transceivers of the second network, wherein said subset is expected to include one or more base station transceivers:

(A1) detected by said particular mobile station, and

(A2) that detects said particular mobile station;

providing the second network with said at least one operating characteristic of said particular mobile station obtained from the first network;

obtaining, in response to said step of providing, additional location information derived at least partially from communications between said particular mobile station and said subset of transceivers related to wireless signals communicated between said particular mobile station and said subset of transceivers;

second activating a second location estimator for providing a second estimate of a location of said particular mobile station, wherein said second location estimator is supplied with said additional location information; and

outputting at least one of the first and second estimates of the location of the mobile station as an estimate of the location of said particular mobile station.

2. A method as claimed in Claim 1, wherein said step of providing includes a prior step of populating a database with mobile station provisioning data, received from a customer care system used by said second network.

3. A method for locating a particular wireless mobile

station during a wireless communication for an emergency response, wherein an area about said particular mobile station is included in a first area for a first wireless network, and in a second area for a second wireless network, said particular mobile station registered with the first network for subscribing to a wireless service, wherein for each network of said first and second networks, the network includes a collection of one or more mobile switching centers, each of the mobile switching centers controlling communications with a corresponding predetermined plurality of geographically dispersed base stations of the network, and each mobile switching center of said collection:

(a1) having access to predetermined identification information for identifying each mobile station registered with the network, said identifying information being accessible by the mobile switching center independently of a communication between the registered mobile station and the mobile switching center, and

(a2) does not have independent access to said identification information for mobile stations not registered with the network,

comprising:

first receiving, during said emergency response communication, first data including: (b1) said predetermined identification information for identifying said particular mobile station, and (b2) location related data obtained from wireless signals communicated between said particular mobile station and the first network, wherein said location data, is capable of changing when said particular mobile station changes location;

selecting the second network as a different wireless network for obtaining additional location related data obtained from wireless signals communicated between said particular mobile station and the second network;

second receiving said additional location related data;

determining a location estimate of said particular mobile station using one or more of said location related data and said additional location related data;

outputting a location estimate of said particular mobile station, wherein said location estimate is derived using said one or more estimates.

4. A method as claimed in Claim 3, wherein one or more of said steps of selecting, second receiving, activating and outputting occur during said emergency response communication.

5. A method as claimed in Claim 3, wherein said step of outputting includes a step of transmitting said at least one location estimator to a Public Safety Answering Point.

6. A method as claimed in Claim 3, wherein said particular mobile station is not registered with said second wireless network.

7. method as claimed in Claim 3, further including a step of requesting that said particular mobile station scan for detecting signals transmitted by base station transceivers of the second network.

8. method as claimed in Claim 7, wherein said step of requesting includes providing a transmission to the first network, wherein said transmission instructs said particular mobile station to perform a scan for detecting signals transmitted by base station transceivers of the second network.

9. Method as claimed in Claim 8, wherein said step of receiving includes determining a base station transceiver identification of a base station transceiver from the second network.

10. A method as claimed in Claim 9, wherein said location related data includes an identification of first set of one or more base station transceivers of the first network such that for each said transceiver at least one of: (a) it detects said particular mobile station, and (b) it is detected by said particular mobile station; and

11. A method as claimed in Claim 10, further including a step of requesting that said transceivers of said second set scan for detecting signals transmitted by said particular mobile station.

12. A method as claimed in Claim 11, wherein said step of requesting includes providing a transmission to the second network, wherein said transmission instructs said second set of transceivers to perform a scan for detecting signals transmitted by said particular base mobile station.

13. A method as claimed in Claim 11, wherein said step of receiving includes determining measurements of wireless signals of a reverse path from said particular mobile station to said transceivers of said second set.

14. A method as claimed in Claim 3, wherein said step of determining includes activating at least one location estimator for providing at least two estimates of a location of said particular mobile station, wherein each said at least one location estimator is supplied with location information derived using at least one of said location related data and said additional location related data.

15. A method for locating a wireless mobile station, comprising:

receiving, by a receiving means, first data related to wireless signals communicated between a particular mobile station and at least a first network of a plurality of commercial mobile service provider networks, wherein for each said network, there are a plurality of base stations for at least one of transmitting and receiving wireless signals with a corresponding plurality of mobile stations registered with the network, and wherein said particular mobile station is registered with said first network for subscribing to a wireless service;

first activating a first location estimator for providing a first estimate of a location of said particular mobile station, wherein said first location estimator is supplied with first location information from said receiving means for deriving said_first estimate, said first location information including data obtained using the first data, said location information capable of changing with a change in a location of said particular mobile station;

wherein when said location estimator supplied with said first location information, said first estimate is one of: (a) is deemed ambiguous, (b) can not be provided, (c) is not within a desired range of accuracy, and (d) has an extent greater than or equal to a predetermined size, then the steps (A1) and (A2) are performed:

(A1) instructing said particular mobile station to communicate with a second network of the plurality of networks for supplying second data to said receiving means, wherein said particular mobile station is not registered with said second network for subscribing to a wireless service, and wherein said second data is [related to] derived using wireless signals communicated between the mobile station and the second network;

(A2) second activating a second location estimator for providing a second estimate of a location of said particular mobile station wherein said second location estimator is supplied with additional location information from said receiving means, said additional location information including data obtained using the second data;

outputting at least one of the first and second estimates of the location of the mobile station as an estimate of the location of the mobile station.

16. A method for locating a wireless mobile station as claimed in Claim 15, wherein said additional location information and said first location information are utilized together by said location estimator.

17. A method of locating a wireless mobile station as claimed in Claim 15, wherein said communication stations include wireless base stations for one of CDMA, TDMA, and GSM.

18. A method of locating a wireless mobile station as claimed in Claim 17, wherein said communication stations include home base stations.

19. A method of locating a wireless mobile station as claimed in Claim 15, wherein the mobile station includes one of: a CDMA transmitter, a TDMA transmitter, and a GSM transmitter, and a AMPS transmitter.

20. A method for locating a wireless mobile station as claimed in Claim 15, wherein one or more of said activating steps includes:

(a) said location estimator for determining whether the mobile station is detected by a communication station which communicates with the mobile station as a cordless telephone;

(b) said location estimator for estimating a location of the mobile station using location information related to data from a distributed antenna system;

(c) said location estimator for estimating a location of the mobile station by one of: triangulation and trilateration.

21. A method for locating a wireless mobile station as claimed in Claim 15, wherein said predetermined extent is less than one thousand feet.

22. A method for locating a wireless mobile station, comprising:

first receiving first signal characteristic measurements of wireless signals communicated between a mobile station and a first network of base stations, wherein said base stations in the first network are cooperatively linked by a first wireless service provider for providing wireless communication;

[instructing] providing to a second network of cooperatively linked base stations for providing wireless services to registered mobile stations [that are cooperatively linked by a second wireless service provider for providing wireless communication so that the] mobile station location data obtained using said first signal characteristic measurements, wherein said second network [searches for] uses said mobile station location data for detecting wireless signals from the mobile station, and wherein said [first and second wireless service providers are different] mobile station is a subscriber of said first wireless service provider's network and mobile station is not a subscriber of said second wireless service provider's network;

second receiving second signal characteristic measurements of wireless signals communicated between the mobile station and said second network of base stations;

estimating a location of the mobile station using said first and second signal characteristic measurements.

23. A method for locating a wireless mobile station, wherein the mobile station communicates via wireless signals with a wireless network infrastructure having a plurality of spaced apart base stations for wireless communication with said first mobile station, wherein said wireless network infrastructure identifies said mobile station by a first identifier for routing substantially all of its communications to said mobile station, comprising:

providing an in-premise transceiver at a predetermined premise address for communicating with said mobile station, wherein said in-premise transceiver routes substantially all communication with said mobile station through a communications network that identifies said mobile station by a second identifier different from said first identifier, wherein the communications network uses said second identifier for routing substantially all of its communications to said mobile station;

storing information relating the premise address and said second identifier;

transmitting, by said in-premise transceiver, a status to the communications network when there is a change as to whether said mobile station and said in-premise transceiver are within a range of one another to wirelessly communicate, wherein said status is_indicative of said change;

storing, in a predetermined storage, said status, wherein a first value is stored when said mobile station is within range for communicating with said in-premise transceiver, and has a second value which is stored when said mobile station communicates with said in-premise transceiver;

retrieving, using at least a portion of said information, said status from said predetermined storage;

determining that the premise address is a location of said mobile station when said first value is retrieved as a value for said status.

24. A method for locating a wireless mobile station, as

claimed in Claim 23, wherein said in-premises transceiver is a home base station.

25. A method for locating a wireless mobile station, as claimed in Claim 23, wherein said predetermined storage is accessible via one of: autonomous notification message and a request-response message.

26. A method for locating a wireless mobile station, as claimed in Claim 23, wherein said predetermined storage is a home location register.

27. A method for locating a wireless mobile station, as claimed in Claim 23, wherein said predetermined storage includes one or more of the following data items related to said mobile station: mobile station identification number, in-premise transceiver identification and mobile switch center identification.

28. A method for locating a wireless mobile station, as claimed in claim 23, wherein said step of transmitting further includes associating said change with a predetermined fixed location and said in-premise transceiver identification.

29. A method for locating a wireless mobile station, as claimed in Claim 23, further including a prior step of provisioning a translating database from a customer care system containing the location of the in-premise transceiver.

30. A method as claimed in Claim 23, wherein said communications network is physically connected by a wire to said in-premise transceiver for communicating with said mobile station.

31. A method as claimed in Claim 23, wherein said communications network includes a public switched telephone

network.

32. A method as claimed in Claim 23, wherein said step of providing includes providing a correspondence in-premise transceiver and said mobile station that is used by said communications network for routing substantially all communications to said mobile station via said in-premise transceiver.

33. A method as claimed in Claim 23, wherein said steps of storing and retrieving include a step of notifying a service control point component of said communications network.

34. A method as claimed in Claim 23, wherein said step of retrieving includes accessing a home location register for said mobile station.

35. A method as claimed in Claim 23, wherein said step of retrieving is performed for determining when to route calls to said mobile station by said first identifier and when to route calls to said mobile station by said second identifier.

36. A method as claimed in Claim 23, wherein said step of retrieving is performed for redirecting a communication to said mobile station, wherein said redirecting is one of: (a) from said in-premise transceiver to said wireless network infrastructure, and (b) from said wireless network infrastructure to said in-premise transceiver.

37. A method as claimed in Claim 36, wherein said redirecting from said in-premise transceiver to said wireless network infrastructure is performed when said second value is retrieved in said step of retrieving.

38. A method as claimed in Claim 36, wherein said redirecting from said wireless network infrastructure to said

in-premise transceiver is performed when said first value is retrieved in said step of retrieving.

39. A method for locating a wireless mobile station, comprising:

receiving data from wireless signals communicated between a mobile station and a wireless network including a plurality of distributed antennas;

detecting, using said data, that the mobile station is in wireless communication with [a] said distributed antenna system having a plurality of antennas connected in series and distributed along a signal conducting line so that there is a predetermined and purposefully introduced signal time delay between said antennas and at predetermined locations;

determining a plurality of signal time delay measurements for signals transmitted between the mobile station and a collection of some of said antennas, wherein said signals are also communicated through said line;

estimating a location of the mobile station using said plurality of signal time delay measurements.

40. A method for locating a wireless mobile station as claimed in Claim 39, wherein said step of estimating includes correlating each measurement of said plurality of signal time delay measurements with a unique corresponding one of said antennas.

41. A method for locating a wireless mobile station as claimed in Claim 39, wherein said step of estimating includes performing a triangulation using values related to one of: a signal time of arrival, and a signal time difference of arrival for time difference of arrival corresponding to each antenna in said collection.

42. A method for locating a wireless mobile station, as claimed in Claim 39 wherein said step of estimating includes a

step of computing a most likely location of said mobile station using a fuzzy logic computation.

43. A method for locating a wireless mobile station as claimed in Claim 39, wherein said step of activating includes activating one of:

(a) a location estimator for determining whether the mobile station is detected by a base station of the network, wherein said base station communicates with the mobile station as a cordless telephone;

(b) a location estimator for estimating a location of the mobile station using location information obtained from said distributed antenna system;

(c) a location estimator for estimating a location of the mobile station by one of: triangulation and trilateration.

44. A method for locating a wireless mobile station, comprising:

first receiving first signal characteristic measurements of wireless signals communicated between a mobile station and a first network of base stations, wherein said base stations in the first network are cooperatively linked by a first wireless service provider for providing wireless communication;

instructing the mobile station to search for a wireless signal from a second network of base stations that are cooperatively linked by a second wireless service provider for providing wireless communication, wherein said mobile station is a subscriber of said first [and second wireless service providers are different] wireless service provider, and said mobile station is not a subscriber of said second wireless service provider;

second receiving second signal characteristic measurements of wireless signals communicated between the mobile station and said second network of base stations; estimating a location of the mobile station using said first and second signal characteristic measurements.

45. A method for locating a wireless mobile station as claimed in Claim 44, wherein the mobile station is registered for a wireless communication service with the first wireless service provider, and the mobile station is not registered for the wireless communication service with the second wireless service provider.

46. A method for locating a wireless mobile station as claimed in Claim 44, wherein said step of instructing includes transmitting a command to the mobile station for instructing the mobile station to search for a signal from a base station of said second wireless service provider in a frequency bandwidth different from a frequency bandwidth for communicating with the base stations of said first wireless service provider.

47. An apparatus for locating a first mobile station, wherein the first mobile station communicates via wireless signals with a first wireless network infrastructure having:

a plurality of spaced apart base stations for wireless communication with said first mobile station, wherein at least one of said first mobile station and said first wireless network infrastructure has a capability for obtaining a plurality of multipath measurements for one of: one or more forward transmissions to said first mobile station, and one or more reverse transmissions from said first mobile station to said first wireless network infrastructure, and wherein said multipath measurements are derived from both fixed clutter and variable clutter, comprising: [wherein said mobile switching center also communicates with said plurality of base stations for receiving measurements of said radio signals, said measurements including:

(i) first measurements of said radio signals received by said first mobile station in said forward radio bandwidth, and (ii) second measurements of said radio signals transmitted by said first mobile station in said reverse radio bandwidth;]

a mobile station location determining system for locating said first mobile station, wherein said location determining system is capable of transforming [receives said first and second] values indicative of said multipath measurements for at least one of said forward transmissions and said reverse transmissions, wherein said transformed values have an enhanced dependence on multipath measurements derived from fixed clutter as compared to multipath measurements derived from variable clutter;

wherein said mobile station location determining system includes at least one wireless location determining model for estimating a location of said first mobile station, said at least one model uses one or more of said transformed values;

a means for transmitting, to said location determining system, said values indicative of said multipath measurements;

a means for outputting, from said location determining system, a resulting location estimate of said first mobile station.

48. An apparatus for locating a mobile station as claimed in Claim 47, further including a means for requesting data related to additional radio signals between said first mobile station and at least a second wireless network infrastructure different from said first wireless network infrastructure.

49. An apparatus for locating a mobile station, comprising:

a wireless network infrastructure for communicating with a plurality of mobile stations, each said mobile station for transmitting and receiving wireless signals, wherein said wireless signals are received in a forward bandwidth and said wireless signals are transmitted in a different reverse bandwidth, and, said wireless network infrastructure having a plurality of spaced apart base stations for communicating via said wireless signals with said plurality of mobile stations;

a location determining means for communicating with said plurality of mobile stations, via said radio signals with the base stations, wherein said location determining means communicates with said plurality of base stations for receiving CDMA finger measurements related to said radio signals for estimating a location of at least a first of said plurality of mobile stations, said measurements including: (i) first measurements of said wireless signals received by said first mobile station in said forward radio bandwidth, and (ii) second measurements of said wireless signals transmitted by said first mobile station in said reverse radio bandwidth;

wherein said location determining means estimates a location of said first mobile station using both said first measurements and said second measurements.

50. An apparatus for locating a mobile station as claimed in Claim 5, wherein said measurements include at least one of: a ratio of energy per bit versus signal to noise, a word error rate, a frame error rate, a mobile signaling means, a power control value, a pilot index, a finger identification, timeoffset, an identification of said first mobile station for communicating with the wireless network infrastructure, a make of said first mobile station, a revision of said first mobile station, a sector identification of one of the base stations receiving said radio signals transmitted from said first mobile station.

51. An apparatus for locating a mobile station as claimed in Claim 49, wherein said location determining means receives

said measurements from a distributed antenna system.

52. An apparatus for locating a mobile station as claimed in Claim 49, wherein said location determining means receives active, candidate and remaining set information from said first mobile signaling means.

53. A method for locating a wireless mobile station, as claimed in Claim 22, further including a step of requesting the mobile station to raise it's transmitter power level to a predetermined level, prior to said step of second receiving second signal characteristics measurements.

54. A method for locating a mobile station, comprising:

receiving, by said mobile station, a request control message from one of a plurality of base stations, wherein said message is received by a receiving antenna of said mobile station;

the control message providing information related to said message to at least one of a control processor and a searcher receiver in said mobile station;

determining, using at least one of said control processor and said searcher receiver, a plurality of multipath finger sets for a wireless communication between said mobile station and at least a first of the base stations, wherein for at least some of said multipath finger sets are different;

transmitting signals for said finger sets to one or more of the base stations via a transmitting antenna of said mobile station;

routing data for at least one of said finger sets from said one or more base stations to a mobile station location estimator for estimating a location of said mobile station.

55. A method for locating a mobile station, as claimed in Claim 54, wherein each of said multipath finger sets includes

at least a pilot offset identification value, an energy per bit over effective power spectral noise plus interference value, and a time offset value.

56. A method for locating a mobile station, as claimed in Claim 54, wherein said step of determining includes a step of instructing, by said control processor, said searcher receiver to output a plurality of said radio signal strength related values for a plurality of fingers resulting from said communication from said first base station to said mobile station.

57. A method for locating a mobile station, as claimed in Claim 54, further including a step of establishing a software controllable data connection between said control processor and a mobile station component including at least one of: a user digital baseband component and said modulator, wherein said connection inputs said data to said component.

56. A method for locating a mobile station, as claimed in claim 54 further said data for said fingers to a mobile station location estimation system having a first mobile station location estimating component using time difference of arrival measurements for locating said mobile station via one of trilateration and triangulation.

59. A method for locating a mobile station, as claimed in Claim 56, wherein said step of providing includes selecting one of: said first mobile station estimating component, a second mobile station estimating component using data obtained from a distributed antenna system, and a third mobile station estimating component for using data obtained from activation of a home base station.

60. A method for locating a mobile station, as claimed in Claim 59, further including a step of computing a most likely

location of said mobile station using a fuzzy logic computation.

61. A method for locating a mobile station, as claimed in Claim 60, wherein said step of computing is performed by said second mobile station estimating component for determining a most likely floor that said mobile station resides in a multi-story building having a distributed antenna system.

62. A method for obtaining data related to wireless signal characteristics, comprising:

providing a user with a mobile station for use when the user traverses a route having one or more predetermined route locations, wherein one or more of the route locations have a corresponding telephone number and a corresponding description stored in the mobile station;

performing the following substeps when the user visits each of the route locations: activating a call to said corresponding telephone number;

transmitting a code identifying the route location when the user is substantially at the route location; storing an association of:

(a) signal characteristic measurements for wireless communication between the mobile station and one or more base stations, and

(b) a unique identifier for the route location obtained using said code transmitted by said call;

Wherein said stored signal characteristic measurements are accessible using said unique identifier.

63. A method as claimed in Claim 62, further including, prior to said step of activating, a step of determining, by the user, that a display on the mobile station uniquely identifies that said corresponding description of the route location is available for calling said corresponding telephone

number and transmitting said identifying code.

64. A method as claimed in Claim 62, wherein said step of storing includes using a phone number identifying the mobile station in combination with said transmitted identifying code for determining said unique identifier.

65. A method as claimed in Claim 62, wherein said corresponding description includes at least one of: a textual description of its corresponding route location, and an address of its corresponding route location.

66. A method as claimed in Claim 62, further including a step of filtering said signal characteristic measurements so that when said signal characteristic measurements are suspected of being transmitted from a location substantially different from the route location, said step of storing is one of: (a) not performed, and (b) performed so as to indicate that said signal characteristic measurements are suspect.

67. A method as claimed in Claim 66, wherein said step of filtering includes at least one of: (a) determining an amount by which an estimated location of the mobile station using said signal characteristic measurements differs from a location of the mobile station obtained from said unique identifier; (b) determining whether a predetermined amount of time has elapsed between successive performances of said step of activating.

68. A method for locating a wireless mobile station, comprising:

first receiving first signal characteristic measurements of wireless signals communicated between a mobile station and a first network of base stations, wherein said first signal characteristic measurements includes:

(a) one or more multipath finger data sets for a wireless communication between the mobile station and at least a first of the base stations;

(b) data identifying operational characteristics of the mobile station including information related to a signal transmission power for the mobile station and information for determining a maximum transmission power level of the mobile station;

adjusting, for at least one of said data sets, using said data, data set has the corresponding adjusted value wherein said adjusted value is an expected value of a predetermined standardized mobile station transmitter power level having a predetermined maximum transmission power and operating at a predetermined transmission power level;

outputting second signal characteristic information, obtained using said adjusted signal strength, to a mobile station location estimator for determining a location estimate of said first mobile station.

69. A method for locating a mobile station as claimed in Claim 68, further including applying a sequence of one or more signal processing filters to one of: said data sets and said adjusted data sets.

70. A method for locating a wireless mobile station, comprising:

first receiving first signal characteristic measurements of wireless signals communicated between a mobile station and a first network of base stations, wherein said first signal characteristic measurements includes one or more multipath finger_measurement sets for a wireless communication between the mobile station and at least a first of the base stations;

categorizing said sets into categories according to ranges of related values for obtaining a representation of a frequency of occurrence of said one or more pairs in said categories;

applying one or more filters to said categorizing sets for one of: (a) reducing characteristics of said representation that are expected to be insufficiently repeatable for use in identifying a location of the mobile station, and (b) enhancing a signal to noise ratio;

supplying an output obtained from said step of applying to a mobile station location estimator;

estimating a location of the mobile station using said mobile station location estimator.

71. An apparatus for locating a mobile station as claimed in Claim 47, further including a means for providing a location estimate using the Internet.

72. An apparatus for locating a mobile station as claimed in Claim 47, further including a means for providing a location estimate using digital certificate keys and the Internet.

73. apparatus for locating a mobile station as claimed in Claim 72, further including a means for providing a location estimate using push technology on the Internet.

74. An apparatus as claimed in Claim 73, wherein said means for outputting includes an Internet web site for transmitting said resulting estimate location from said location determining system to a predetermined Internet address.

75. An apparatus as claimed in Claim 74, further including

encryption/decryption modules for providing secure Internet communications between said Internet web site and said predetermined Internet address.

76. An apparatus as claimed in Claim 75, wherein said predetermined Internet address corresponds to an Internet receiving client at an emergency assistance service center, wherein an identification of said first mobile station is provided to said emergency assistance service center substantially concurrently with the location of said first mobile station being transmitted to said location determining system.

77. An apparatus as claimed in Claim 76, wherein said receiving client is used at an emergency response center.

78. A method for locating a first mobile station, wherein the first mobile station communicates via wireless signals with a first wireless network infrastructure having a plurality of spaced apart base stations for wireless communication with said first mobile station, wherein at least one of said first mobile station and said first wireless network infrastructure has a capability for obtaining a plurality of multipath measurements for one of: one or more forward transmissions to said first mobile station, and one or more reverse transmissions from said first mobile station to said first wireless network infrastructure, and wherein said multipath measurements are derived from both fixed clutter and variable cluster, comprising:

transmitting, from said first wireless network infrastructure to a location determining system, values indicative of said multipath measurements;

transforming said values indicative of said multipath measurements for at least one of said forward transmissions and said reverse transmissions, wherein said transformed values have an enhanced dependence on multipath measurements derived from fixed clutter as compared to multipath measurements derived from variable cluster;

determining at least one wireless location estimate of said first mobile station using one or more of said transformed values;

outputting said location estimate of said first mobile station.

79. A method as claimed in Claim 78, wherein said first mobile station and said first wireless network infrastructure communicate using CDMA.

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(71) Applicant: MITEL CORPORATION [CA/CA]; 350 Legget Drive, P.O. Box 13089, Kanata, Ontario K2K 1X3 (CA).

(72) Inventor: DEADMAN, Richard; 80 Evelyn Avenue, Ottawa, Ontario K1S 0C7 (CA).

(74) Agent: MITCHELL, Richard, J.; Marks & Clerk, P.O. Box 957, Station B, Ottawa, Ontario K1P 5S7 (CA).

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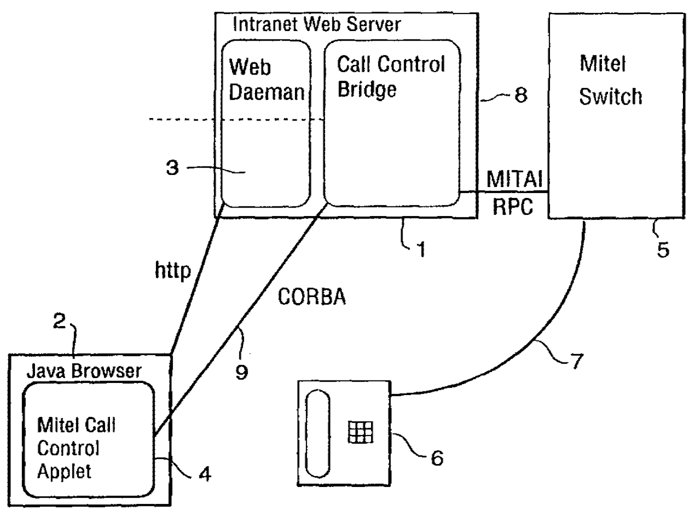


(57) Abstract

A remote call control system comprises a local area network, a network server, a call control server, a plurality of client machines connected to the network server over the local area network, and a telephone switch responsive to instructions from the call control server using a call control protocol to establish connections between telephone sets. Call control applets are downloaded on demand from the server to the client machines for running on the clients. A call control bridge for passes control messages between the applets running on the client machines and the call control server to permit a user operating a client machine to exercise selective control over calls controlled by the call server.

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# NETWORK CONTROL OF TELEPHONY SERVICES USING DOWNLOADABLE APPLICATIONS

This invention relates generally to the field of telephony, and in particular to a remote call control system for use in a local area network environment.

The Telephony industry has provided a large set of features for managing and controlling telephone calls. Generally users have had to use either the limited interface of their telephone or expensive add-on applications with specific set-up environment requirements. Now that public telephone companies are providing many of these same features to their users through such features as Centrex, the problem is moving past the private branch exchange (PBX) and into the home. Both business and home users are faced with trying to figure out how to do simple tasks, such as call forwarding, using arcane DTMF and switch-hook sequences.

Studies show that of the dozens of features offered on modern PBXs, only a small number are usable by the average user. The transferring of a call is often preceeded by a warning such as "if I lose you...". Other features, which may be useful to the user, are too difficult to access or are totally invisible.

Client Call Management applications which provide the user with an interface on a computer for controlling telephones have emerged as one alternative. They provide easier access to features and customization of telephony requirements. Unfortunately, such applications tend to be costly, difficult to install and maintain, and are limited in platform availability. For these reasons, they have tended to be limited to specific high demand users, such as call centres. The typical low-demand user has not been able to benefit from the enhanced interface available within a computer' s graphical user interface. For many businesses, this has led to the purchasing of expensive telephone sets for their PBX system, which only provide limited extra functionality.

An object of the invention is to alleviate this problem.

According to the present invention there is provided a remote call control system comprising a local area network, a network server, a call control server, a plurality of client machines connected to the network server over the local area network, a telephone switch responsive to instructions from said call control server using a call control protocol to establish connections between telephone sets, means for downloading on demand call control applets from said server to said client machines for running on said clients, and a call control bridge for passing control messages between said applets running on the client machines and said call control server to permit a user operating a client machine to exercise selective control over calls controlled by the call server.

The invention makes use of platform independent mobile and downloadable software components in distributed computing environments. A downloadable application can be provided which is platform independent and does not need to be installed or maintained on the client machines. Such an application, with a communication path back to a telephone switch, can provide enhanced telephony notification and control to any user with a net-work connected computer.

This invention thus provides a general framework for implementing a mobile telephony client which can use a distributed environment for remotely controlling a telephony server or switch.

The invention will now be described in more detail, by way of example, only with reference to the accompanying drawings, in which the single figure is a block diagram of a remote call control system in accordance with the invention.

Referring to the Figure, a local area network comprises a network application server 1 and a plurality of client machines 2 connected to the application server in a conventional manner, for example, using an Ethernet connection. The application server 1 includes a Web Daemon 3 for providing HTML documents and Java applets. The client machine 2 includes a Java-enabled web browser 4 capable of running Java applets downloaded from the web browser 4.

Java is a hardware-independent interpreted language from Sun Microsystems, which enables mini-programs or "applets" to be downloaded from the server and run on the client machines 2.

A PABX 5, such as a Mitel corporation PABX, is connected to telephone sets 6 over telephone lines 7. The PABX has a MiTAI, Mitel Telephony Application Interface, and is responsive to instructions in the MiTAI call control protocol to set up calls between telephone sets 6. Alternatively, TSAPI or TAPI interfaces could be used.

The application server 1 includes a call control bridge 8 connecting a call control server 9 to the switch 5. The bridge 8 exchanges messages with the call control server 8 using "COBRA", which stands for Common Object Request broker Architecture. The call control bridge 8 communicates with the switch 5 using the MiTAI interface. In addition, the call control bridge 8 communicates with the client machines 2 over the local area network.

The remote call control system thus consists of the application server 1, the call control server 9, a downloadable platform independent application (applet), and a platform and language independent communication protocol, and a client virtual machine that can download and run the applet.

The application server 1 sends the downloadable application or applet to the client's virtual machine 2 on demand. The applet is executed on the virtual machine 2 and sets up a COBRA connection with the call control server 9 via the call control bridge 8, thereby allowing the user of the client application control over some set of calls controlled by the call Server 9. The applet can register interest in certain events with the call server 9. When these events occur on the server, the applet is notified so that it can take the appropriate action, such-as popping up an "incoming call" window.

User I.D.s and passwords or IP mapping tables can be used for identifying access levels and matching the application to a telephony line. Both individual and group line management services can be provided. Remote debugging of switches and whiteboard conferencing between parties in a call can also be provided.

In the preferred implementation, Hypertext Transport Protocol and associated Hypertext Markup Language browsers are used as the client interface. Sun Microsystem's Java language serves as the platform independent application language. CORBA, the platform independent standard for distributed object message passing, provides messaging between the client applet and the Call Control Server.

The call control bridge 8 exports CORBA objects to client machines and interacts using standard telephony APIs to the PBX 5 controlling the telephone calls.

The Java Applet which registers with the call control bridge and provides control and notification of calls to the client's desktop.

In operation, when the Java-enabled Web browser accesses the Call Control HTML page on the Server, the browser downloads a Java Applet which includes classes for a Java CORBA Object Request Broker. In this way, CORBA is distributed to the clients on an as-needed basis. No installation, customization or management of client-side machines is required, as long as they have a Java enabled browser. When started, the Java applet on the client machines presents a log-in screen. When the user logs in, the applet uses the CORBA classes to connect to the server and then ex-changes object references with the server. A window is created on the client machine that allows the user to use the Call Control applet even as they move on to browsing other Web pages. Asynchronous messages from the server are handled by the applet to update the applets state; in particular, incoming call events cause the applet to pop a window up on the user's screen to alert them to the incoming call.

The invention thus enables a user on a client machine to have selective access to telephone control features on an as needed basis.

The invention can thus provide the control of telephony switches through downloadable applications, the notification of calls through downloadable applications, the control of telephone calls through a World Wide Web HTML browser, such as Netscape, the provision of a COBRA to Telephony API bridge for object oriented telephone calls, client to telephony permission mapping through network addressing, remote debuggin of telephony switches through wide area networks, and data transfer between parties over wide-are networks coordinated with standard telephony calls.

Claims:

1. A remote call control system comprising a local area network, a network server, a call control server, a plurality of client machines connected to the network server over the local area network, a telephone switch responsive to instructions from said call control server using a call control protocol to establish connections between telephone sets, means for downloading on demand call control applets from said server to said client machines for running on said clients, and a call control bridge for passing control messages between said applets running on the client machines and said call control server to permit a user operating a client machine to exercise selective control over calls controlled by the call server.

2. A remote call control system as claimed in claim 1, wherein said network server includes a call control bridge for exchanging messages between said applets and said call control server using object oriented control of calls.

3. A remote call control system as claimed in claim 2, wherein call control server is connected to said switch through a telephony Application Programming Interface.

4. A remote call control system as claimed in claim 3, wherein said network server includes a web daemon, and said client machine includes a web browser for accessing a call control page on said web daemon.

5. A remote call control system as claimed in claim 1, wherein said web browser is Java-enabled for running a Java call control applet on the client machine.

6. A remote call control system as claimed in claim 1, wherein said applets provide notification of calls to users of client machines.

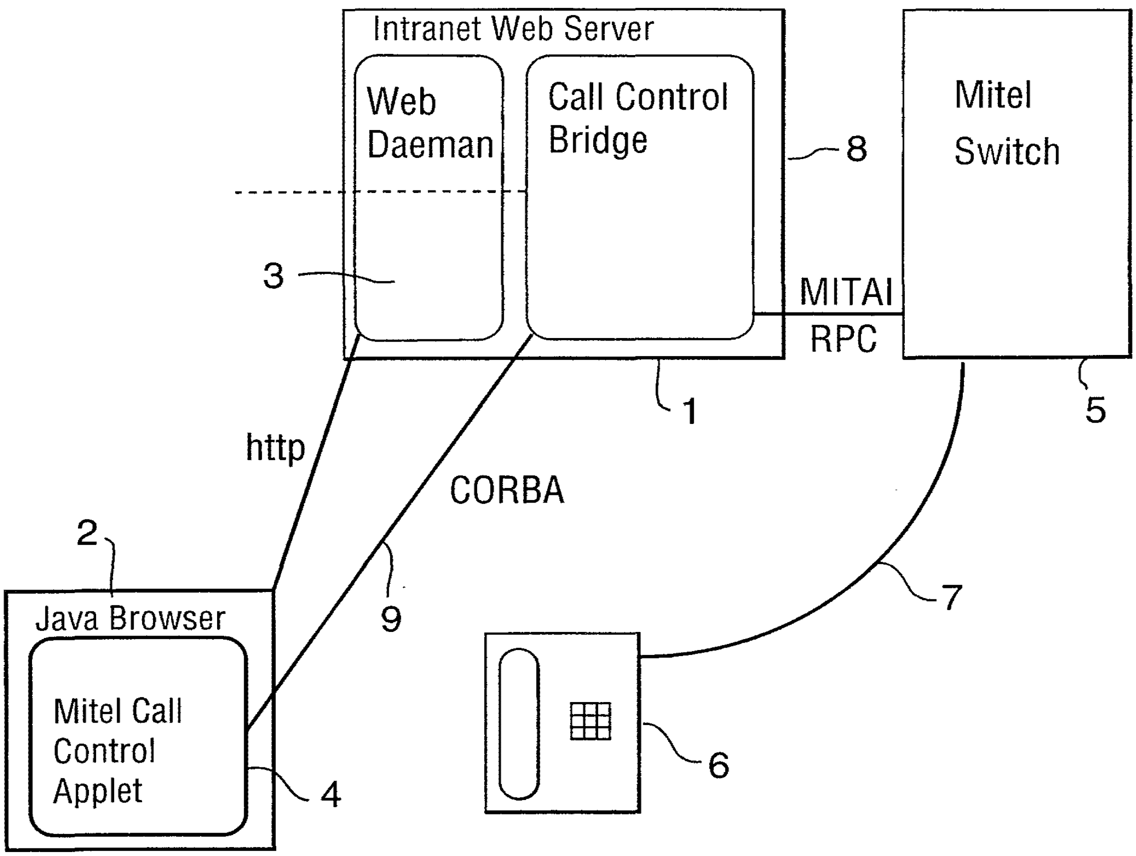
7. A method of controlling telephone calls from a client machine in a local area network environment, comprising downloading on demand call control applets from a network server to client machines, for running said applets on said clients, passing control messages between said applets running on the client machines and a call control server to permit a user operating a client machine to exercise selective control over calls setup by a switch controlled by the call server.

8. A method as claimed in claim 7, wherein said messages between said applets using object oriented control of calls.

9. A method as claimed in claim 8, wherein said applets are accessed using a web browser running on a said client machine.

10. A method as claimed in claim 9, wherein said web browser is Java-enabled.

11. A method as claimed in claim 7, wherein said applets provide pop-up windows to offer notification of calls to users of client machines.

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# INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 97/00733

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 6 H04M3/00 H04M3/42 H04Q3/00

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
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**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| X | LOW C ET AL: "WEBIN - AN ARCHITECTURE FOR FAST DEPLOYMENT OF IN-BASED PERSONAL SERVICES" WORKSHOP RECORD. INTELLIGENT NETWORK. FREEDOM AND FLEXIBILITY: REALISING THE PROMISE OF INTELLIGENT NETWORK SERVICES, 21 April 1996, pages 1-12, XP002043670 see the whole document --- | 1-11 |
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(71) Applicant: TELEFONAKTIEBOLAGET LM ERICSSON (publ) [SE/SE]; S-126 25 Stockholm (SE).

(72) Inventor: TRÄNK, Jörgen; Hallonstigen 3, S-651 15 Kil (SE).

(74) Agent: TELEFONAKTIEBOLAGET LM ERICSSON; Patent and Trademark Dept., S-126 25 Stockholm (SE).

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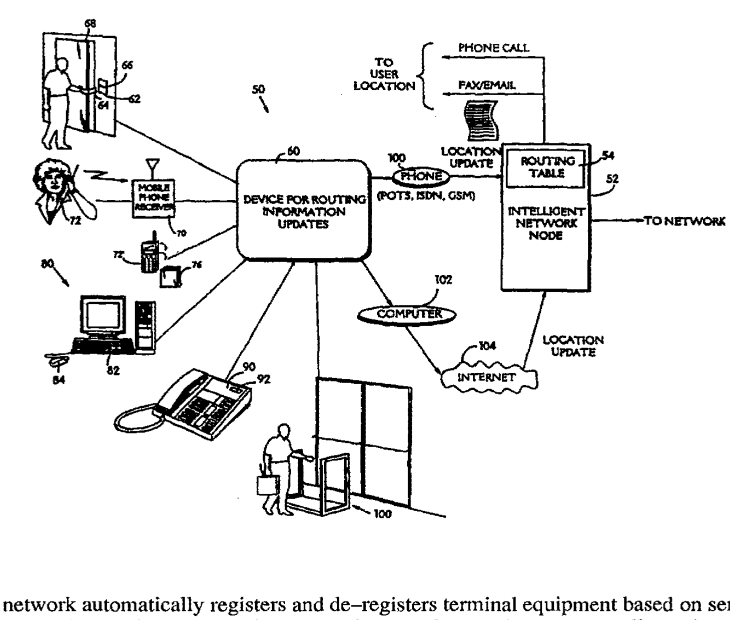


(57) Abstract

A telecommunications network automatically registers and de–registers terminal equipment based on sensed user location. A Universal Personal Telecommunications (UPT) user does not need to remember or take the time to manually register upon arriving at a location or de–register before leaving a location. Instead, automatic sensing devices sense when the UPT user arrives and/or leaves a location. A device for routing information updates automatically generates and sends UPT registration and de–registration messages to an Intelligent Network node in response to sensed user location. The Intelligent Network node updates its routing tables in response to the messages, and automatically routes user calls to the appropriate terminal locations based on the routing tables.

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# DEVICE FOR ROUTING INFORMATION UPDATES

## Field of the Invention

This invention relates to telecommunications networks such as Intelligent Networks. Still more particularly, this invention relates to Universal Personal Telecommunications, and to systems and methods for automatically updating a telecommunications network concerning the location of a Universal Personal Telecommunications user.

## Background and Summary of the Invention

People have more convenient access to telecommunications devices than ever before. Almost everyone has a telephone at home, and most of us also have a telephone at work. Some people also carry portable cellular telephones with them wherever they go. We can see people talking on digital pocket phones in the car, in restaurants, in shopping malls and at the beach.

This multiplicity of communications devices theoretically allows a person to be contacted wherever he or she happens to be. However, the process of successfully reaching a particular person has become complicated. Nowadays, when you ask for someone's telephone number, it is common to get back a list of phone numbers: the work number, the home number, the cellular phone number, the work facsimile number, the home facsimile number, an electronic mail address, etc. All of these telephone numbers are difficult to remember. One must also guess which numbers to try first. It can take a long time to dial the numbers in the list until you finally try the right one. Failed attempts can be expensive if the caller is calling long distance and an answering machine, fax machine or voice mail answers the telephone in the person's absence.

"Universal Personal Telecommunication" ("UPT") addresses this problem. The objective of personal telecommunications is to provide a means of communicating with anyone, anytime, anywhere -- whether at work, at home or on the move. Under the UPT concept, the telecommunications network takes care of routing your call to the correct telephone or other terminal device. You request the network to connect you to the person you want to reach -- not to a place or a particular terminal. You need not know where this person is for the moment -- the network will find out.

In UPT, the fixed association between terminal access and user identification is removed. The network treats identification of UPT users separately from the addressing of terminals and network access points. Any UPT user can make and receive calls on any terminal. The so-called "Intelligent Network" ("IN") architecture can be used to efficiently implement Universal Personal Telecommunications. See, for example, S derberg, L., "Evolving an Intelligent Architecture for Personal Telecommunication", 4 Ericsson Review 156-170 (1993); Sundborg, J., "Universal Personal Telecommunication (UPT) -- Concept and Standardisation", 4 Ericsson Review 140-155 (1993); and Wallinder, S., "Implementation of UPT--Universal Personal Telecommunications", 1 Ericsson Review (1994).

Because UPT user identification is independent of telephone or other terminal addressing, the telecommunications network must have some way of locating users so it can associate them with nearby telephones or other terminals. UPT requires the network to be constantly updated about UPT users' locations, to enable routing of phone calls and email/fax to the right network address (extension/location). This locating process is sometimes called personal mobility call registration.

In the past, personal mobility registration has been carried out manually, i.e., the user of the service has to access the service from some kind of terminal and manually tell it to associate that (or a different) terminal with the user for the time at least. For example, the UPT user can register a terminal address for incoming calls -- telling the network to route all incoming calls for that user to that terminal address. The UPT user can also register outgoing calls so all outgoing calls from a terminal will be charged to the user. The call registration is made as an update of the UPT user's current terminal address. Such updates are normally done by means of DTMF tone signaling from an ordinary telephone, or via computer terminals connected to the Intelligent Network service management system.

For example, in the standard telephone example, when the UPT user arrives at a new location he can pick up a standard telephone set and dial the UPT service. The user may be required to input his personal universal telephone number and an associated personal identification number or other password to identify and authenticate himself to the UPT service. The UPT service may prompt the user with a voice menu. The user can make selections by depressing corresponding touch-tone buttons on the standard telephone set. One of the options may be "personal mobility." Upon selecting this option, the user may be prompted concerning what kind of registration he desires (e.g., register incoming calls, register outgoing calls, or registering all calls). Upon depressing an appropriate touch-tone button to select registration type, the service may prompt the user to enter the terminal address of the terminal device he is registering and the time when registration is to expire.

In another prior registration example, the user may use a display device to access the UPT service. The display enables the UPT user to receive graphical information on the screen, and to respond by touching the screen, using a mouse or pressing buttons on a separate keyboard. See Sundborg (cited above), Figure 12.

An appropriate node (or nodes) in the network updates its routing table upon receiving a call registration. From then until the registration is canceled or superseded, the network will route all incoming calls for that UPT user to the registered terminal address -- and may also charge the user for all calls outgoing from that terminal address. The registration may have a certain valid time period associated with it. A new call registration from the same UPT user will cancel the one made previously. The UPT user can explicitly de-register -- breaking the association between the user and a network address.

A significant problem with prior personal mobility features described above is that the user has to remember (and take the time) to update the network routing table each time he or she changes location. If the user forgets or doesn't take the time to manually update the network, the network will be unable to direct messages to the right location and terminal. This can cause serious problems. For example, the network may erroneously direct an important personal call to the user's work phone after the user has gone home for the day.

The prior art includes various techniques for locating subscribers and routing calls to subscriber locations. For example:

U.S. Patent No. 5,506,887 teaches an Advanced Intelligent Network system providing a personal communication service to subscriber wireless handsets or other portable devices (e.g., laptop computers). When a wireless unit comes within range of a mobile base station, the mobile base station automatically dials and informs the central network controller of the registration.

WO 95/34985 (Alcatel) discloses a subscriber ID card that can be remotely interrogated. Each terminal device which recognizes, through remote interrogation, that the subscriber is nearby reports this fact to the service operator. Calls addressed to the subscriber are directed to the service operator and from there, to whatever terminal device reported last.

WO 95 01070 (Ericsson) discloses sensing when a mobile phone has been placed into a battery charger; and sending a message from the battery charger to the telephone network. This message causes the network to route, to a fixed telephone at the same location, calls directed to the mobile phone. The battery charger similarly detects when the mobile phone has been removed from the charger, and sends a message to the network that causes the network to route, to the mobile phone, calls directed to the fixed telephone.

EP 0520194 (Network Access) discloses a radio tracking system for tracking the location of a telephone user. The user carries a personal communicator that transmits radio signals to the tracking system. The tracking system tracks the user's location, and sends information to the telephone system service node. The service node stores this information in a look-up table along with the directory telephone number of the phone at the subscriber's current location.

EP 0578374 (Northern Telecom) discloses a building access control system using badges. The system determines when subscribers leave and access a building -- and in some cases, where the subscribers are within the building. A telephone switch uses this information to redirect calls to the phone nearest the subscriber.

EP 0 433 465 (NTT) discloses a personal telephone number system. Registration is provided automatically when a portable telephone is connected by a cable to the system. See page 11, lines 11-15.

However, further improvements are possible. For example, none of these references specifically mentions how automatic subscriber locator features including a means that can sense the location of a subscriber without requiring the subscriber to carry portable telephone equipment, can be integrated with an intelligent network architecture.

The present invention relieves the user of having to manually update the network or the UPT service with the user's location. The present invention solves the manual updating problem by providing methods and devices for automatically generating personal mobility location updates and providing them to the network. By means of a special device connected to either a telephone or to a personal computer/workstation, the telecom service is notified each time the service user is visiting the location where the device is located. The device is capable of detecting when the user is entering/leaving the location where the device is located. Because the UPT service is automatically informed of the user's location, the chance an incoming phone call, facsimile transmission and/or electronic mail message reaching the user is much higher.

When the device detects that the service user is entering the premises, a "location update" is sent to the network node where the routing table is stored. The network node updates the routing table with the terminal address of the nearest terminal (e.g., the phone/fax number and/or email address of the terminal) -- automatically registering the terminal for that user. When the device detects that the service user leaves the premises, it sends another "location update" to the network to de-register the user with respect to that terminal at that location.

Detection of service user presence at a specific location can be accomplished in any of several ways. For example, the network can detect user presence by:

- using information in electronic security locking systems (e.g., where the user must slip a card in a card reader to enter the building);
- detecting "location updates" sent from a mobile phone;
- detecting when a mobile phone is put into its battery charger;
- executing a small application on a personal computer/workstation that lets the user indicate his presence by a single keystroke or mouse "click";
- depressing a special key on a telephone set; and/or

- using an anti-theft system to detect when the user enters/leaves his room or building.

The detection device can be connected to the telecom service in any of several different ways depending upon access method, for example:

- the device send routing updates by means of DTMF signaling (POTS) over a standard telephone link, user-to-user information (ISDN) over an ISDN link, or through use of USSD (GSM) signaling over a GSM link; or

- the device can be connected to a personal computer/workstation, and can send routing updates by means of electronic mail messages over the Internet or other computer network.

Brief Description of the Drawings

These and other features and advantages provided by the invention will be better and more completely understood by referring to the following detailed description of presently preferred embodiments in conjunction with the drawings, of which:

Figure 1 shows a telecommunications system including a device for routing information updates;

Figure 2 is a flowchart of example steps performed by the device for routing information updates; and

Figure 3 is a flowchart of example steps performed by an intelligent network node.

Detailed Description of Presently Preferred Example Embodiments

Figure 1 shows an example overall telecommunications system 50. System 50 may include an Intelligent Network architecture having at least one Intelligent Network node 52. Node 52 may be part of a larger Intelligent Network architecture. Node 52 stores a routing table 54. Routing table 54 may be used as part of the Universal Personal Telephone (UPT) service to route incoming telephone calls, facsimile transmissions and/or electronic mail messages to particular terminals such as stationary or mobile telephones, fax machines, computers or other terminal devices.

System 50 also includes a device 60 for routing information updates to node 52. In the preferred embodiment, device 60 routes location updates informing node 52 of users' locations. For example, device 60 informs network node 52 when a particular user has arrived at a particular location, and when a particular user has departed from a particular location. Node 52 treats such location updates as UPT call registration or de-registration requests. More specifically, node 52 changes the information in routing table to reflect current user location as indicated by the location updates.

Device 60 includes or is connected to a sensing means for sensing user location. The sensing means can comprise any number of different arrangements or a combination of different arrangements.

In one example, the sensing means can comprise an electronic security locking system 62 or other electronic lock. In this example, the user must slip a card 64 into a card reader 66 to open a door 68 and enter or exit a room or building. When the user slips card 64 into the card reader 66 to enter, the security system 62 senses this and sends a message to the device 60 identifying the card holder. Device 60 sends a corresponding message to node 52 indicating that the identified user is on the premises and can receive telephone calls and other communications there. If the user needs to slip card 64 into the card reader 66 to exit, the security system 62 senses this and sends another message to device 60. Device 60 can send a corresponding message to node 52 indicating that the particular user is no longer on the premises and therefore cannot receive telephone calls or other communications there.

In another example, device 60 can be connected to a conventional mobile telephone receiver 70 of the type that receives mobile telephone location update messages. Such messages are sent periodically by standard mobile telephones 72 whenever they are turned on and operating, to allow cellular communications networks to keep track of which cell the mobile telephones are operating in. Device 60 can respond to such location update messages by automatically generating and sending location update messages to node 52. Node 52 may use such location update messages to register the mobile telephone as the device to which incoming calls for the phone's owner should be routed, and can route incoming calls to mobile phone 72.

In yet another example, device 60 can be connected to a mobile phone battery charger 76. Battery charging station 76 can alert device 60 whenever mobile phone 72' is placed into the battery charging station. Device 60 can send a location update/registration message to node 52 that de-registers mobile phone 72' as being the user's terminal, and registering the stationary telephone at the charging station 76's location (e.g., the user's home).

In still another example, device 60 can be connected to a conventional personal computer/workstation 80 that runs a small application allowing the user to indicate his presence very simply (e.g., by a single keystroke on keyboard 82 and/or by a "click" of mouse 84). Device 60 can, upon receiving a user presence indicating message from personal computer/workstation 80, send a location update message to node 52 effectively registering the personal computer/workstation (and/or telephones or other telecommunications equipment co-located with the personal computer/workstation) as being the user's destination network address. This registration can expire a certain amount of time after initial registration, or it can stay effective until the user registers from another location.

In yet another example, device 60 can be connected to a conventional telephone set 90 having a special key 92. When the user depresses key 92, device 60 can send a location update message to node 52 registering telephone set 90 as the user's incoming telephone call destination. When the user depresses key 92 again (or depresses a different, "de-registration" key), device 60 can send a further location update message that de-registers telephone set 90 for the user.

In yet another example, device 60 can be connected to a security system 100 of the type shops use to prevent theft. In this example, every user carries a badge, card or other object having a personalized transducer that electronically indicates user identity. Security system 100 detects when the user walks into the room or building, and also detects when the user walks out of the room or building. Security system 100 sends responsive messages to device 60, which in turn sends location update information to node 52 for purposes of registering or deregistering particular terminal devices at the location with respect to particular users who have walked through the security system 100.

The location update information generated by device 60 may include the following information for example:

user identity information (e.g., user's UPT number or another identification from which the network node 52 can derive the user's UPT number);

registration/deregistration indicator (i.e., whether the user is arriving or leaving the location); and

an optional registration time duration (e.g., in the case of sensing devices that sense only arrival and not departure, the registration can be set for a certain number of hours such as the length of a work day for registering a place of work).

Device 60 can be connected to node 52 through any number of different communications paths. In one example, device 60 is connected through a standard telecommunications link such as DTMF (POTS) signaling, user-to-user information (ISDN) signaling, or USSD (GSM) signaling. In another example, device 60 can be connected to node 52 through a computer 102. Computer 102 can route messages from device 60 to node 52 through electronic mail or other messages over a computer network such as the Internet 104.

Figure 2 shows example steps performed by device 60. In this example, device 60 senses the user's arrival at a certain location (Figure 2, decision block 150). If the user has not yet arrived, device 60 keeps on checking periodically. Device 60 senses when the user arrives and is on site ("yes" exit to decision block 150), and sends a location update message to node 52 that registers the telecommunications devices at the location (Figure 2, block 152). Device 60 may then, if desired, sense user departure from the location (Figure 2, decision block 154). If the user has not yet departed, device 60 waits and keeps on checking. Device 60 senses when the user departs from the location (Figure 2, "yes" exit to decision block 154), and sends a corresponding location update to node 52 that de-registers the telecommunications devices at the location.

Figure 3 shows an example process performed by node 52. In this example, node 52 determines whether it has received a location update from device 60 (Figure 3, decision block 200). If it has ("yes" exit to decision block 200), node 52 retrieves the network addresses of the telecommunications devices of the corresponding location from a database (block 202), and writes those network addresses into routing table 54 (Figure 3, block 204). If node receives an incoming call for the user ("yes" exit to decision block 206), node 52 routes the call to the user location based on the routing information contained within routing table (Figure 3, block 208).

The present invention thus allows a telecommunications network to automatically register and de-register terminal equipment based on sensed user location. The UPT user does not need to remember to manually register upon arriving at a location or de-register upon leaving a location. Instead, automatic sensing devices sense when the UPT user arrive and/or leave a location, and a device for routing information updates automatically generates and sends UPT registration and/or de-registration messages to an intelligent network node in response to sensed user location.

While the invention has been described in connection with various preferred embodiments, the embodiments have been presented by way of example only, and not limitation. The breadth and scope of the present invention should not be limited by any of the described example embodiments, but to the contrary, should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. A telecommunications system having an intelligent network architecture, the system comprising:

an intelligent network including at least one intelligent network node, the intelligent network node storing at least one intelligent network universal personal telephone service routing table and routing calls to users at least in part in response to the routing table contents;

at least one means for sensing user location without requiring the user to carry portable telephone equipment; and

a device for routing information updates coupled to the sensing means and to the intelligent network node, the device for routing information updates generating intelligent network universal personal telephone service location update messages in response to the sensing means and sending the intelligent network universal personal telephone service location update messages to the intelligent network node, the intelligent network node updating its intelligent network universal personal telephone service routing table at least in part in response to the location update messages.

2. A telecommunications system as in claim 1 wherein the sensing means comprises a personal computer including a keyboard and a mouse, the personal computer running a small application that allows the user to indicate his presence by a single keystroke on the keyboard and/or clicking the mouse.

3. A telecommunications system as in claim 1 wherein the location update message includes a user UPT number, a registration/deregistration indicator, and an optional registration time duration.

4. A telecommunications system comprising:

an intelligent network including at least one intelligent network node, the intelligent network node storing at least one routing table and routing calls to users at least in part in response to the routing table contents;

at least one means for sensing user location; and

a device for routing information updates coupled to the sensing means and to the intelligent network node, the device for routing information updates generating location update messages in response to the sensing means and sending the location update messages to the intelligent network node, the intelligent network node updating its routing table at least in part in response to the location update messages.

5. A telecommunications system as in claim 4 wherein the sensing means comprises an electronic lock.

6. A telecommunications system as in claim 4 wherein the sensing means comprises a mobile phone receiver responsive to location updates generated by a mobile phone.

7. A telecommunications system as in claim 4 wherein the sensing means comprises a mobile phone battery charging station that senses when a mobile phone is coupled thereto.

8. A telecommunications system as in claim 4 wherein the sensing means comprises a computer that senses user manipulation thereof.

9. A telecommunications system as in claim 4 wherein the sensing means comprises a telephone set including a special key, the special key, in use, being depressed by the user to indicate user presence at the location of the telephone set.

10. A telecommunications system as in claim 4 wherein the sensing means comprises a security system that automatically senses user passage through a security zone.

11. A telecommunications system as in claim 4 further including means for coupling the routing device to the intelligent network node.

12. A telecommunications system as in claim 11 wherein the coupling means comprises a standard DTMF telephone signaling line.

13. A telecommunications system as in claim 11 wherein the coupling means comprises an ISDN signaling link.

14. A telecommunications system as in claim 11 wherein the coupling means comprises a GSM signaling link.

15. A telecommunications system as in claim 11 wherein the coupling means comprises means for sending a message over the Internet.

16. A method of registering a terminal to a user comprising:

(a) automatically sensing user presence at a location having at least one terminal;

(b) generating a location update message in response to step (a); and

(c) in response to the location update message generated by step (b), registering the terminal to the user sensed by step (a).

17. A method as in claim 16 wherein sensing step (a) comprises sensing user operation of an electronic lock.

18. A method as in claim 16 wherein sensing step (a) comprises sensing receipt of at least one mobile phone location update message.

19. A method as in claim 16 wherein sensing step (a) comprises sensing coupling of a mobile phone to a battery charger.

20. A method as in claim 16 wherein sensing step (a) comprises sensing user operation of a computer device.

21. A method as in claim 16 wherein sensing step (a) comprises sensing user depression of a special button mounted on a telephone set.

22. A method as in claim 16 wherein sensing step (a) comprises sensing user passage through a security system.

23. A method as in claim 16 further including transmitting the location update message to an intelligent network node over the Internet.

24. A method as in claim 16 further including transmitting the location update message to an intelligent network node over a conventional telecommunications link.

25. In a telecommunications network of the type including a Universal Personal Telecommunications service that enables the network to route incoming communications directed to a particular user to any of a multiplicity of terminal devices, a method of automatically de-registering a terminal device comprising:

(a) automatically sensing user departure from the terminal device location;

(b) generating a location update message in response to step (a); and

(c) in response to the location update message generated by step (b), deregistering the terminal with respect to the user sensed by step (a).

26. A method as in claim 25 wherein the sensing step senses the identity of the user, and the generating step generates a location update message that encodes sensed user identity.

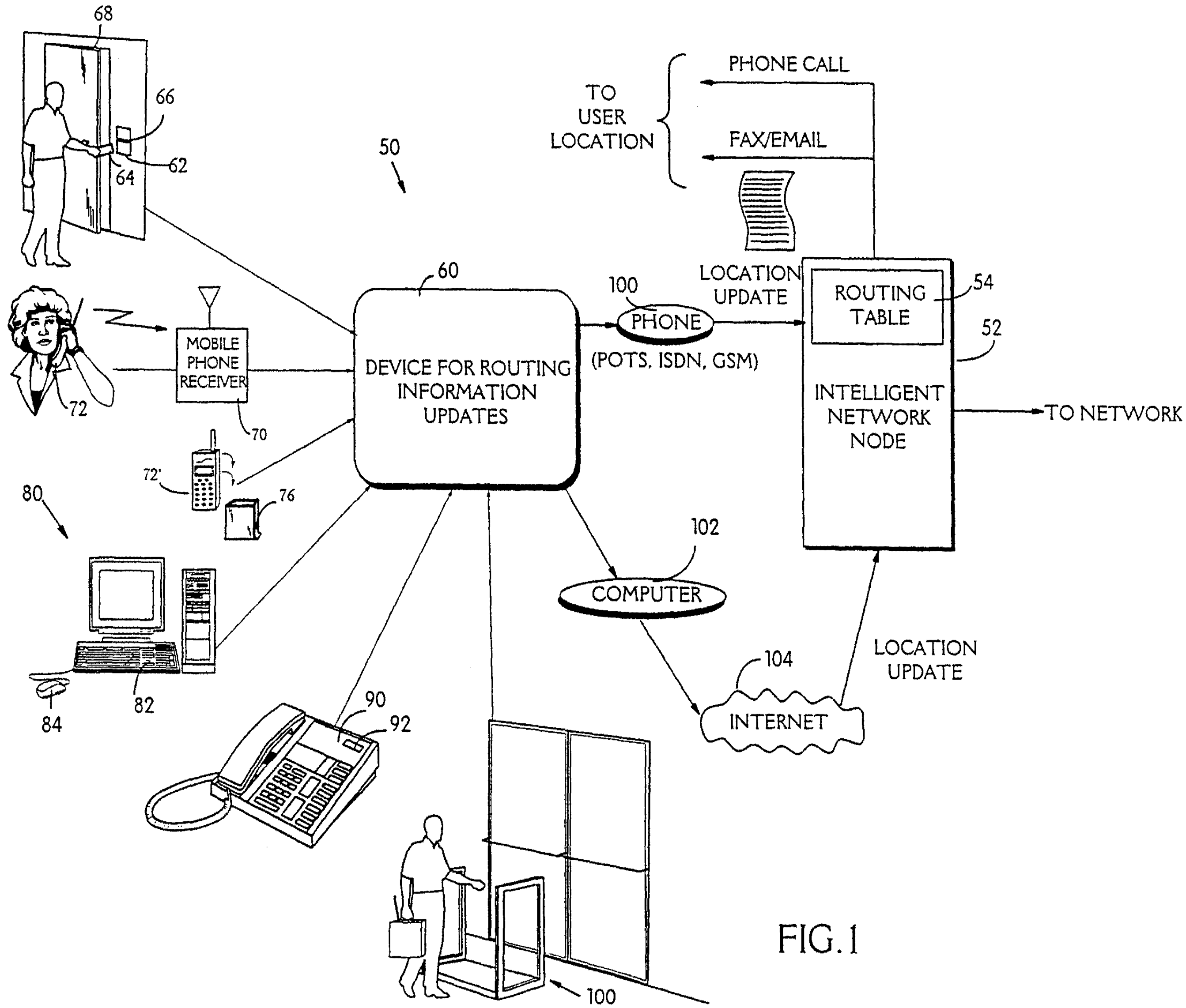
68
66
62
64
50
TO
USER
LOCATION
PHONE CALL
FAX/EMAIL
LOCATION
UPDATE
ROUTING
TABLE
54
52
60
100
PHONE
(POTS, ISDN, GSM)
MOBILE
PHONE
RECEIVER
72
70
DEVICE FOR ROUTING
INFORMATION
UPDATES
INTELLIGENT
NETWORK
NODE
TO NETWORK
72'
76
80
102
COMPUTER
104
LOCATION
UPDATE
INTERNET
84
82
90
92
100

FIG.1

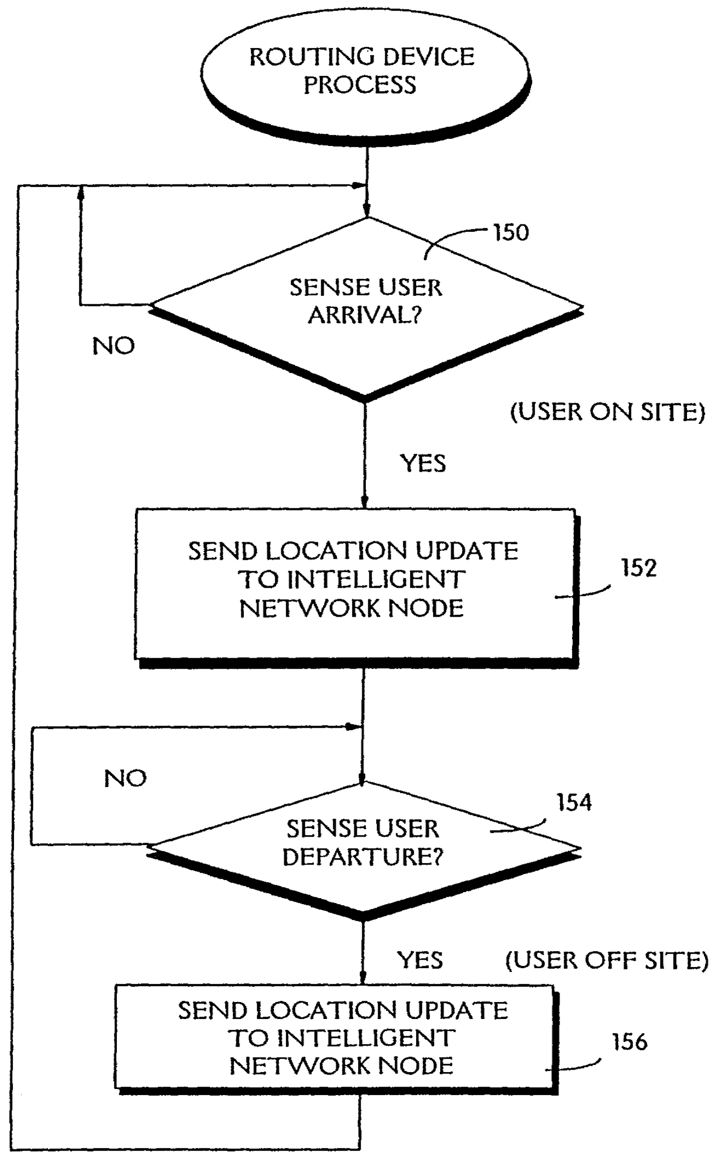
ROUTING DEVICE PROCESS
150
SENSE USER ARRIVAL?
NO
(USER ON SITE)
YES
SEND LOCATION UPDATE TO INTELLIGENT NETWORK NODE
152
NO
154
SENSE USER DEPARTURE?
YES
(USER OFF SITE)
SEND LOCATION UPDATE TO INTELLIGENT NETWORK NODE
156

FIG.2

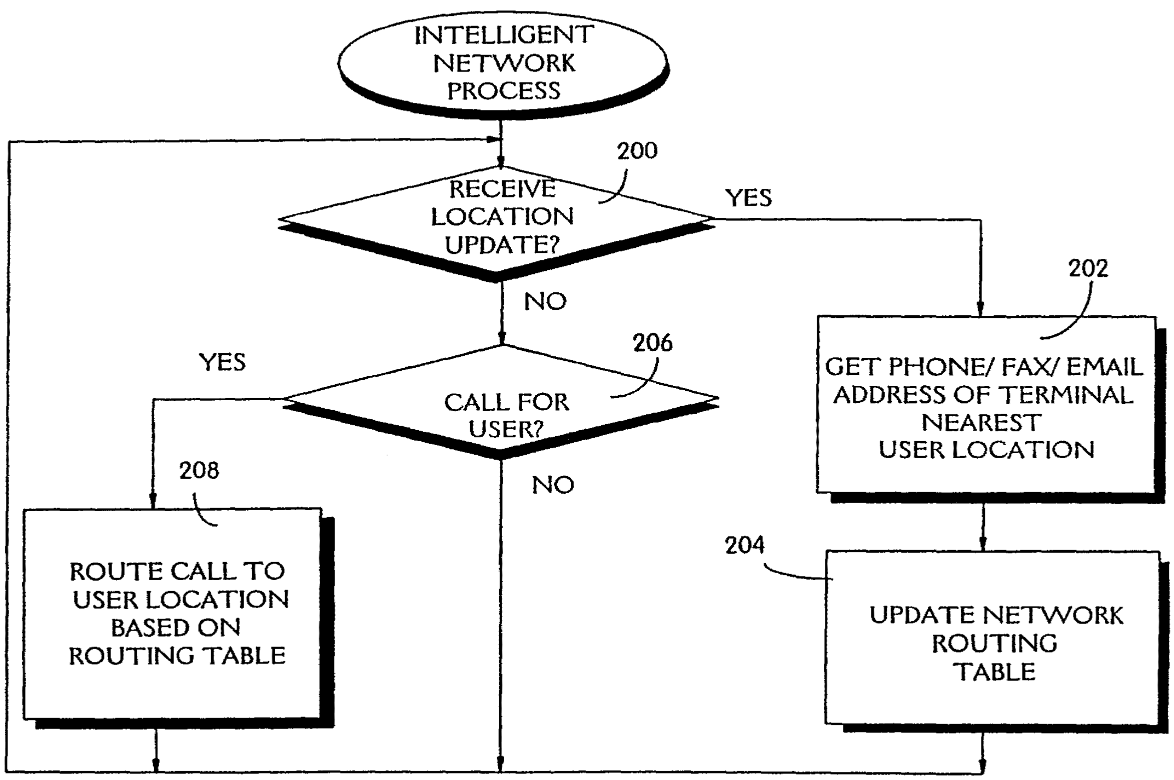
INTELLIGENT NETWORK PROCESS
200
RECEIVE LOCATION UPDATE?
YES
NO
202
GET PHONE/ FAX/ EMAIL ADDRESS OF TERMINAL NEAREST USER LOCATION
206
CALL FOR USER?
YES
NO
208
ROUTE CALL TO USER LOCATION BASED ON ROUTING TABLE
204
UPDATE NETWORK ROUTING TABLE

FIG.3

# INTERNATIONAL SEARCH REPORT

Inter .onal Application No
PCT/SE 97/01896

**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 6 H04Q7/38 H04M3/42

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q H04M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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[X] Further documents are listed in the continuation of box C.

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(71) Applicant: MCI COMMUNICATIONS CORPORATION [US/US]; 1133 19th Street, N.W., Washington, DC 20036 (US).

(71)(72) Applicant and Inventor: WILSON, James, E. [US/US]; 3908 Bosque Drive, Plano, TX 75074 (US).

(74) Agents: WARREN, Sanford, E., Jr. et al.; Warren & Perez, Suite 710, 8411 Preston Road, Dallas, TX 75225 (US).

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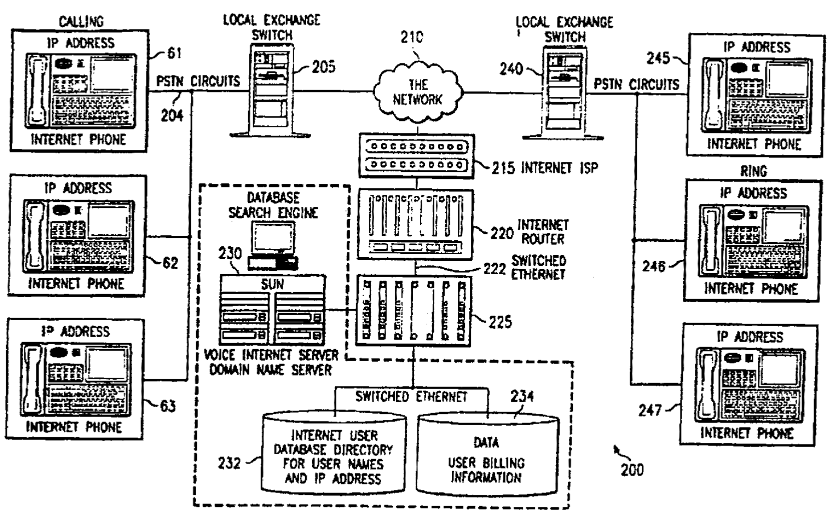
(54) Title: INTERNET PHONE SYSTEM AND DIRECTORY SEARCH ENGINE USING SAME




(57) Abstract

An Internet compatible dialer pad is used to dial into an Internet server to provide services similar to those found on the Plain Old Telephone System ("POTS"). The dialer pad has an integrated modem set, an extended keypad with alphanumeric entry keys and function keys, display screen and display electronics that renders visual call progress information to the user as well as other communications indicators and related information about the current Internet connection. The dialer uses the Public Switched Telephone System ("PSTN") and standard LAN/WAN technology to give the user entry into a plurality of Internet calling functions. An Internet database is maintained and permits the dialing party to obtain callee information by entering alphanumeric characters via the dialer. Links from the PSTN to an Internet data base are not restricted to a specific digital data protocol.

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# INTERNET PHONE SYSTEM AND DIRECTORY SEARCH ENGINE USING SAME

## TECHNICAL FIELD

The invention relates in general to a system for transmitting voice date over the Internet and, more specifically, to a network architecture that permit voice communications using the Internet Protocol with alphanumeric to Internet address conversion using a directory search engine and a data base of potential callees.

BACKGROUND OF THE INVENTION

The Internet has become the information "superhighway" of choice for an ever increasing number of individuals who have turned to it as an inexpensive and effective way of exchanging electronic data and information. While often thought of as a world-wide network, in reality the Internet is comprised of numerous different networks throughout the world which are linked together using a common routing protocol known as the Internet Protocol ("IP"). This architecture provides widespread access from an unspecified number of terminals or other dial-up equipment around the world.

Individual users, groups and other entities are identified on the Internet by a unique address conforming to the IP. A local access hub provides users with an entry way into the Internet network and acts as the exchange point for both incoming and outgoing data. The data flows along virtual channels consisting of a plurality of gateways, data routers and other physical equipment which work together to form a signal path from message origin to its intended destination. Since a point-to-point connection is never established, the costs to the user are limited to those charged by the local Internet access provider and/or a nominal periodic access fee.

The low cost associated with Internet use has spurred the development of audio applications that allow users to receive and transmit compressed Internet voice messages across the Internet. Typically, a user at one end of the connection speaks into a microphone attached to a Personal Computer ("PC"). The microphone carries the audio voice signal to a processor board in the PC which digitizes the signal and creates a digital voice file. The voice file is compressed and transferred to a selected recipient at a distant point on the Internet. Once received, the voice file is decompressed and converted via digital signal processing to an audible signal intelligible to the human ear.

The typical Internet audio set includes a PC, modem, Internet access software, file compression software and operating system. The user executes the software off the PC's hard disk or floppy drive and the modem provides the hardware communications link with the local Internet access provider. This operation involves turning the PC ON, executing the software, gaining access to the Internet, recording the voice file and transmitting its intended recipient. At the receiving end, the process is substantially the same but in reverse.

While such applications are available and useful for inexpensive long distance calling on the Internet, they do require ownership or access to a computer and some knowledge regarding the installation, operation and execution of the accompanying software. In short, these prior art audio sets have not yet replaced the Plain Old Telephone System ("POTS") on a widespread basis. The POTS, on the other hand, has widespread appeal and provides intuitive operation.

In essence, audio applications for the Internet are still in their infancy. Problems with voice quality and awkward user interfaces detract from their use. As such, the wide array of telephone services available to POTS users are not yet available to complement existing Internet audio sets.

More specifically, with present Internet audio sets, the user is required to know the address of the voice file recipient. When an IP address is dialed, up to 20 digits have to be entered by the caller. Remembering and entering these digits is neither appealing nor practical in most situations.

Before Internet calling becomes a standard in main stream long distance calling applications, the process needs to be eased for the average garden variety long distance caller who would prefer to place a call in the easiest manner possible. Use of the POTS along with their chosen long distance carrier meets their needs since a long distance call over the POTS requires no special equipment, knowledge or information and results in a greater chance of getting through the intended callee.

Thus, a system that combine the simplicity of operation of the POTS with low cost audio access to the Internet would provide numerous advantages over prior Internet audio sets.

SUMMARY OF THE INVENTION

It has been found the prior audio communications systems for the Internet are cumbersome to use and do not provide the functionality long distance callers have come to expect from their more familiar telephone set.

As such, it is a primary object of the present invention to provide a system that simplifies the use of the Internet for long distance calling applications. The invention defines a combination of network elements that provide the user with a POTS look-a-like dialing pad. The dialing pad has an alphanumeric keypad and screen display which provides visual call progress information to the user.

Another object of the present invention is to provide a device that is similar to the POTS. In this regard, a true telephone phone set, one that doesn't require to be booted up to run a standard PC, is provided with a phone keypad for DTMF dialing similar to a regular phone. The set includes a hand set with a receiver and mouth piece and can be used to make voice connections via the PSTN and compressed audio using the Internet protocol.

Still another object of the present invention is to provide a simplified calling means for originating a call on the Internet. A list of known callees can be stored internally inside the dialer and retrieved by the user prior to going off-hook. For unknown callee addresses, a method of address conversion is provided wherein the user enters the alphabetic name of a potential caller on the dialing pad and the name is searched on a user data base to arrive at the corresponding Internet address.

Yet another object of the present invention is to provide a means of initiating an Internet call without prior knowledge of the callee's Internet address. In this regard, an directory engine and user data base of known IP addresses is maintained on a specialized network server accessed through the pad, the PSTN and the other existing Internet components. When a hit is made on the data base, the name is returned to the user on the dial pad's display screen. A caller simply enters the alphabetic string name and the directory engine converts the string to its Internet address equivalent for the callee or callees in the database. When more than one hit is made, all of the matching names are displayed on the dialer screen permitting the calling party to scroll the list and selected the intended callee.

In one aspect, the present invention defines an Internet compatible dialer pad with an integrated modem set that is operated by the user via an extended keypad with alphanumeric entry keys and function keys. The dialer has an integrated display screen and display electronics that renders visual call progress information to the user as well as other communications indicators and related information about the current Internet connection.

In another aspect of the invention, the dialer uses the Public Switched Telephone System ("PSTN") and standard LAN/WAN technology to gain access to a plurality of Internet enhanced calling systems. A directory search engine and user data base permit the caller to obtain callee information by entering alphanumeric characters on the dialer's keypad. Links from the PSTN to an Internet data base are not restricted to a specific digital data protocol. Suggested transmission protocols for the data base and search engine include ATM, ISDN or others depending on data traffic.

For a more complete understanding of the present invention, including its features and advantages, reference is now made to the following detailed description, taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

Figure 1 illustrates a prior art Internet audio set;

Figure 2 is a top side view of the Internet dialer pad according to part of the invention;

Figure 3 is a detailed circuit diagram for the dialer pad shown in Figure 2 according to embodiment of the invention;

Figure 4 is an architectural block diagram of an Internet directory search engine according to one embodiment of the invention;

Figure 5 is an architectural block diagram of an enhanced Internet phone directory search engine according to one embodiment of the invention; and

Figure 6 is a call progress flow diagram for an Internet phone directory connection according to one embodiment of the invention.

Corresponding numerals refer to corresponding parts in the figures unless otherwise indicated.

## DETAILED DESCRIPTION OF THE INVENTION

In Figure 1, a prior art Internet audio set is shown and denoted generally as 10. Internet set 10 includes a personal computer (PC) 15 with a keyboard 17 and monitor 19. Inside the PC 15 are a plurality of application programs which are stored generally on hard disk 21. A microphone 23 is communicably attached to the PC 15 via cable 25 which carries audio signals from the user to a processing board 27. The processing board 27 digitizes the voice signal and creates a voice file which can be stored on hard disk 21 prior to transmission.

In operation, a user gains access to the Internet via an application program stored on hard disk 21. The manner and steps involved in such a process vary depending on the type of PC 15 and software program used. A plurality of Internet access providers may be used for this purpose wherein the user subscribes to the provider and uses a modem 29 to establish the communications link between the user and the provider. In general, the user executes a voice recording program stored on hard disk 21. The voice recording program accepts an audio signal input via the microphone 23 and operates the processing board 27. Other PC 15 functions can be operated using keyboard 17.

The processing board 27 receives the audio analog signal from the user via the microphone 23 and cable 25 and creates a corresponding digital file using on-board digital signal processing. The techniques and methods of digital signal processing are well known in the industry and by those skilled in the art.

Next, the user selects an intended recipient from the application program interface and the digital audio file is sent to the chosen recipient via the modem 29. As shown, the modem 29 is communicably attached via cable 31 to the Public Switched Telephone Network ("PSTN") 33. Call and transmission progress information are displayed on monitor 19 depending on the status of the connection. For example, the monitor 19 can display the recipient, connection status and latest activity. Other information can be displayed depending on the software program used and the functionality of the Internet audio set 10.

The audio set 10 can also be used to receive audio files using the PSTN 33 connection and modem 29. In general, a transmitting party at a distant location uses the address of the audio set 10 to transmit digitized audio messages over the Internet in the manner described above. The audio set 10, and more specifically processing board 27, receives the incoming audio signal and transforms it to its corresponding analog equivalent. The analog audio signal is broadcast over the PC speaker 35 which is controlled by the audio application software.

Thus, the prior art audio set 10 provides a mechanism for voice communications over the Internet using the above described process and hardware shown in Figure 1. Variations of set 10 are also available using similar methods of operation and allowing users a plurality of similar functionality. Such systems, however, are substantially similar in that they depend on use of a PC 15, application programs, and other similar equipment as shown in Figure 1.

Turning now to Figure 2, one aspect of the invention is shown, the phone dialing pad, and denoted generally as 50. Dialing pad 50 has many of the features of a Plain Old Telephone System ("POTS") including hand set 55 which has an ear piece 58 and a mouth piece 56 for hearing and speaking, respectively. The hand set 55 can be used to transmit and receive the pure analog audio signals, which are digitized and processed for transmission on the network.

As shown, the hand set 55 is communicably attached via cable 57 to base 59. The base 59 houses the various telecommunications devices as herein described and as can be appreciated by those skilled in the art.

Accessible from on the top 61 of base 59 are various keys and input devices which control the operation and functionality of the dialing pad 50. An alphanumeric keyboard 63 provides a QWERTY type interface from which the user can enter alphabetic and numeric entries and messages to be included in the Internet message stream. The keyboard 63 is similar to the input device of a typical desktop computer.

In one embodiment, a numeric keypad 65 is shown and provided to give the identical Dual Tone Multifrequency ("DTMF") push button operation of a POTS. Thus, in operation a user lifts the hand set 55 and dials into the PSTN using keypad 65 to make normal voice DTMF telephone calls. In this way, POTS functionality is provided by the dialing pad 50 according to one embodiment.

A microphone 67 is provided on the base 59 and used to receive and transmit audible signals from and to the user. The microphone 67 is controlled by internal electronics inside the base 59 (see Figure 3) and provides audible incoming and outgoing audio signals. In the alternative, audio signals can be received and transmitted via the hand set 55 using the ear 56 piece and mouth piece 58, respectively.

According to one embodiment, an Internet access button 69 is provided on the base 59 and used to switch between normal DTMF voice calls and Internet dial-up operations. In this way, access button 69 can be used to initiate an Internet connection using the internal modem set (not shown in Figure 2) without interrupting the present DTMF initiated switched voice connection.

An integrated display screen 71 is provided to give the user visual information about the current Internet connection as well as other connection/status information. For example, the display screen 71 can show the current callee, a stored list of available callees including their Internet addresses, the identity of the transmitting party and his Internet address, a list of the most currently received or transmitted messages or other similar information according to the preprogrammed functionality of the dialer pad 50.

As such, it should be understood that a wide range of information may be displayed on the display screen 71. In the preferred embodiment, display screen 71 is a liquid crystal display of the type commonly found in industry.

The dialing pad 50 connects to the PSTN via jacks 80 and 82 which provide dual line access to the PSTN via outlets 84. This configuration provides concurrent DTMF and Internet connections. In an alternative embodiment, single line access is provided wherein the dialing pad 50 is used as either a DTMF voice or Internet audio set per single session. In one embodiment, the connection mode is selected by the user with button 69.

A connection 88 to a computer 90 is also provided to permit the transfer of Internet formatted messages between the dialing pad 50 and the computer 90. An RS232 jack 86 is the preferred interface between the Internet phone 50 and the computer 90 for serial data transfers although other connection protocols, such as parallel bus, may be used.

In Figure 3, a circuit diagram for the dialing pad 50 is shown and denoted generally as 100. Circuit diagram 100 is one possible arrangement of components. Those skilled in the art will appreciate that other configurations may be employed. The components are maintained inside the base 59 and assembled during manufacturing by well known means such as on a printed circuit board. Standard off-the-shelf components which are readily available in the market place may be used for most devices and, as such, no particular or specific device is necessary to achieve the objects of the invention as herein described.

As shown, a telephone line interface 102 serves as a connection between the PSTN and the dialing pad 50. A supervisory circuit 104 provides the Onhook/Offhook mechanism between the interface 102 and the PSTN and is operated by the optical isolator 106. The analog signal is received superimposed on a DC level carrier which is isolated via the transformer primary 108.

The analog signal is dropped across the secondary portion 110 of the line transformer where it is load balanced and received by the modem data pump 112. In essence, the telephone line interface 102, isolator circuit 106, and transformer 108, 110 form a direct access arrangement of the type well known by those skilled in the art. It should be understood, however, that other similar configurations and methods of interfacing the modem data pump 112 to the PSTN can be used.

The modem data pump 112 is controlled by CPU controller 116 via path 114. In various embodiments, the data pump 112 supports a plurality of data transmission, compression and error correction protocols including, without limitation, V.34, V.32, V.22, V.42 LAPM, MNP2-5 and still others. Such protocols are well known by those skilled in the art.

An audio compression circuit 118 is also shown coupled to the data pump 114 via path 117 which supports known Internet audio standard protocols such as G.723, G.725 and G.729. The compression circuit 118 also supports G.711 which is the standard audio protocol for all POTS. As shown, circuit 118 is coupled to the primary 108 via coil

120 allowing bidirectional audio transmission through and from the PSTN.

A speaker 130 and microphone 132 are provided to provide the user with an audible signal output and voice input, respectively. During an Internet audio session, the optical isolator circuit 106 enables the microphone 132 portion of the circuit 100 via path 107. Signals from the microphone 132 are received by the compression circuit 118 and transferred to the data pump 112 for signal processing and transmission on the PSTN to its intended recipient using well known modulation/demodulation techniques.

Likewise, signals received from the PSTN via the data pump 112 are deencoded by the compression circuit 118 and delivered to the user via the speaker 130 as an audible output signal. The corresponding multiplexing logic (M1 and M2) are shown arranged in Figure 3 per one embodiment.

DTMF functionality is supported via transceiver circuit 140 and phone keypad 142. This arrangement gives the Internet phone 50 DTMF dial-up capabilities for normal voice connections on a switched circuit basis and alphanumeric entry during Internet sessions. The phone keypad 142 combines the inputs from the keyboard 63 and keypad 65 shown in Figure 2 and is coupled to the controller 116 via pathway 144. The controller 116 is programmed to select the correct input device depending on the type of connection, either standard DTMF or Internet Protocol.

The preferred display screen 71 is a Liquid Crystal Display of the type known to those skilled in the art and is controlled by display driver circuit 150 and controller 116 via path 144. Other system components include memory circuits 155 and 157, which, provide the microprocessor with permanent and erasable memory area segments for performing the various functions herein described. Such functions include power-up sequences, system checks and other standard system verification processes as well as call connect functions, user features and still others.

One feature of the Internet phone is the ability to connect to existing Internet access provider services without requiring extensive software knowledge by the user. In one embodiment, access parameters are maintained on the erasable and programmable memory circuit 157. The access parameters control how the phone 50 connects to the user's Internet access provider.

In one embodiment, the user is prompted to enter a plurality of access parameters such as the provider's telephone number, IP address, domain name server address, user name, password and other similar parameters during initial setup. The Internet access setup program is stored internally by the controller circuit 116 and input by the user is accomplished using the phone keypad 142. These parameters are stored in memory circuit 157 and used for connection to the provider once the Internet access button 69 is depressed.

The controller 116, as shown, initiates the connection using the parameters stored in the memory circuit 157. In this regard, a setup program can be internally maintained and executed upon initial use or setup by the user.

Also, the erasable memory circuit 157 can be used to store a list of common recipients by their Internet addresses. Alternatively, the user creates new recipients for further use and retrieval using the alphanumeric keyboard 63 of the phone keypad 142.

Other system components are illustrated in Figure 3 such as watch dog timer circuit 160, audio speaker phone 162 and ringer adjustment circuit 165 all of which are well understood by those skilled in the art.

Turning now to Figure 4, an architectural model illustrating the Internet address search directory system according to another aspect of the invention is shown and denoted generally as 200. As shown, a plurality of caller dial pads 201, 202 and 203 are connected to a local exchange switch 205 via PSTN circuits 204. The PSTN circuits 204 and local exchange switch form part of the local telephone network within the user's geographic area.

For Internet connections, exchange 205 routes the incoming calls from the dial pads 201, 202 and 203 to the user's Internet Service Provider ("ISP") 215 via established Network 210 paths. Next, the message is parsed and decoded to determine the recipient before routing 220 it using switched Ethernet circuits 222. As is appreciated by those skilled in the art, various routing methods and network devices 225 may be employed to establish the end-to-end message path.

As shown, a plurality of callees 245, 246 and 247 are situated at a second location. The callees 245, 246 or 247 may have an established Internet audio connection and prepared to receive the audio message from any one of the callers 201, 202 or 203. Alternatively, the callees 245, 246 or 247 may dial in to their service provider 215 and obtain the sent audio message at a later time. Typically, the audio file message is stored by the service provider in an electronic mail box until it is delivered to its intended recipient.

In short, audio calls made from the dial pads 201, 202, 203 are routed through the network 210 and reach a second local exchange switch 240 at a distant geographic location.

The local carrier determines the circuit to the appropriate callee 245, 246, or 247, who, in turn, can respond to original caller in like fashion. The process can be repeated to permit conversations of varying lengths similar to those achieved with the POTS.

Address Conversion

Using the Data Base Search Engine 230, a caller (201, 202 or 203) may initiate a call to a callee (245, 246 or 247) without prior knowledge of the callee's Internet address. The dial pad 50 has an internal memory area where a list of callee Internet addresses can be stored for future call operations. Alternatively, the search engine 230 can store the Internet addresses on user data base 232 and convert the alphanumeric callee identifier to its corresponding Internet address.

A callee search can also be performed using the user data base 232. A call request is made at the caller side 201, 202 or 203 using the alphanumeric keypad (63 in Figure 2). At this point, the data stream is parsed to determine if a search request has originated from any one of the dial pads 201, 202 or 203. If so, the request is forwarded to the Data Base Search Engine 230 which is configured to process the request for authorized users. This functionality can be provided to users who have ordered or cleared for Internet voice services similar to ordering calling features such as waiting or call return with the POTS.

Alternatively, the audio functions can be provided to users on a per use charge basis. If so, the billing information can be maintained on the user billing information database 234.

The search engine 230, user data base 232 and user billing information database 234 provide the means for converting alphanumeric call identifiers to their equivalent Internet address format thus eliminating the need to remember and enter numeric Internet routing addresses conforming to the Internet Protocol.

This greatly simplifies the use of the Internet for long distance calling applications. When a callee's address matching the caller's 201, 202, 203 search request is found, the name is displayed on the display screen 71 of the dial pad 50. The caller then has the option of completing the call to the address. When more than one hit is made, the names of the qualifying user callees are displayed. The caller then has the option of selecting from a scrolled list of potential users using the dial pad's keyboard 63 to select the intended caller.

The architectural scheme of Figure 4 can be enhanced to provide further audio functionality over the Internet. In Figure 5, a more sophisticated Internet phone directory search engine topology is depicted and denoted generally as 250. T1 trunk lines 252, 300 connect the local exchange switches 205, 240 to the local ISPs 215, 305 and to network switches 302, 304. Likewise, ISDN circuits 254, 256 can provide the link between the network 210 and servers functions 308, 310 and 312. This topology bridges service providers of varying levels of functionality (those that do not provide directory search functions) to an ISP having the Internet conversion features such as those described herein.

Thus, a single user data base 232 can be accessed by a wide range of ISPs at different locations. Links from the PSTN to an Internet data base are not restricted to a specific digital data protocol. Suggested transmission protocols for the data base and search engine include ATM, ISDN or others depending on data traffic.

The bridge, router gateways 220 and 258, provide the virtual pathways from ISPs 215 and 305 to servers 308, 310 and 312. A single user data base 232, user billing information database 234, mail server 276 and email data base 278 provide network wide functionality.

Also shown is ATM network server 262 directly coupled to the Internet DNS 308 giving ATM network users the same

Internet conversion advantages of the present invention. An audio conversion switch 260 provides the conversion from Internet audio formats G.725, G.729 to audio phone formats G.711.

Thus, by providing a plurality of connections between the audio conversion servers 308, 310, 312 and other network Internet access points, users at many different network levels can take advantage of the present invention.

Turning now to Figure 6, a call progress flow diagram for connection to the directory search engine 230 is shown and denoted generally as 350. The process starts with step 357 wherein a user 355 initiates a call by dialing out to establish an Internet connection 360. A successful connection is acknowledged 362 and the call routed 364 to the directory engine 365. The directory engine 365 transmits a response acknowledge 366 to the user 355 and prompts the user 355 for a callee name 368.

Next, the user 355 enters an alphanumeric character string and sends it 370 in an Internet formatted message to the directory engine 365. The message is parsed and a data base search is performed 372 to find all user names and addresses of matching callees. Once the search is completed, the database responds 374 and the search results are transmitted to the user 376.

The calling party selects a callee from the response list 378 and a record of the callee's Internet address is sent to the user data base 380 for future reference. At this point, the caller can place the call using the found Internet address or start another search 382. If a dial attempt is made, the user accepts the address and dials 386 to the selected callee.

While this invention has been described and referenced to illustrative embodiments, the description is not intended to be construed in a limiting sense. Various modifications and combinations of illustrative embodiments as well as other embodiments and inventions will become apparent to those persons skilled in the art upon reference or description. It is, therefore, intended that the pendent claims encompass any such modifications or embodiments.

What is claimed is:

1. An network system for converting an alphanumeric Internet callee identifiers to their corresponding Internet Protocol address comprising:

a plurality of caller dial pads each of which has an alphanumeric keyboard for entering the Internet callee identifiers, a display screen and an integrated modem set for dialing over the Internet;

a first local exchange switch within the geographic vicinity of said caller dial pads;

switched telephone circuits extending from the caller dial pads to said first local exchange switch that provide telecommunication pathways to the Internet;

at least one Internet service provider communicably connected to the Internet for receiving said Internet callee identifiers through said local exchange switch;

an Internet router coupled to said Internet service provider;

a plurality of switched protocol circuits for receiving Internet formatted data from said Internet router; and

an Internet directory search engine communicably coupled to said switched protocol circuits for receiving said Internet callee identifiers.

2. The network system of Claim 1 wherein said Internet directory search engine further comprises:

an Internet Domain Name Server bidirectionally coupled to said switched protocol circuits; and

an Internet user data base containing a plurality of callee Internet Protocol formatted addresses, said data base accessible to said server.

3. The network system of claim 1 further comprising:

a second local exchange switch communicably attached to the Internet;

a plurality of callee dial pads communicably attached to said second local exchange switch via a plurality of switched telephone circuits, said callee dial pads configured to receive Internet formatted messages origination from said caller dial pads via the Internet.

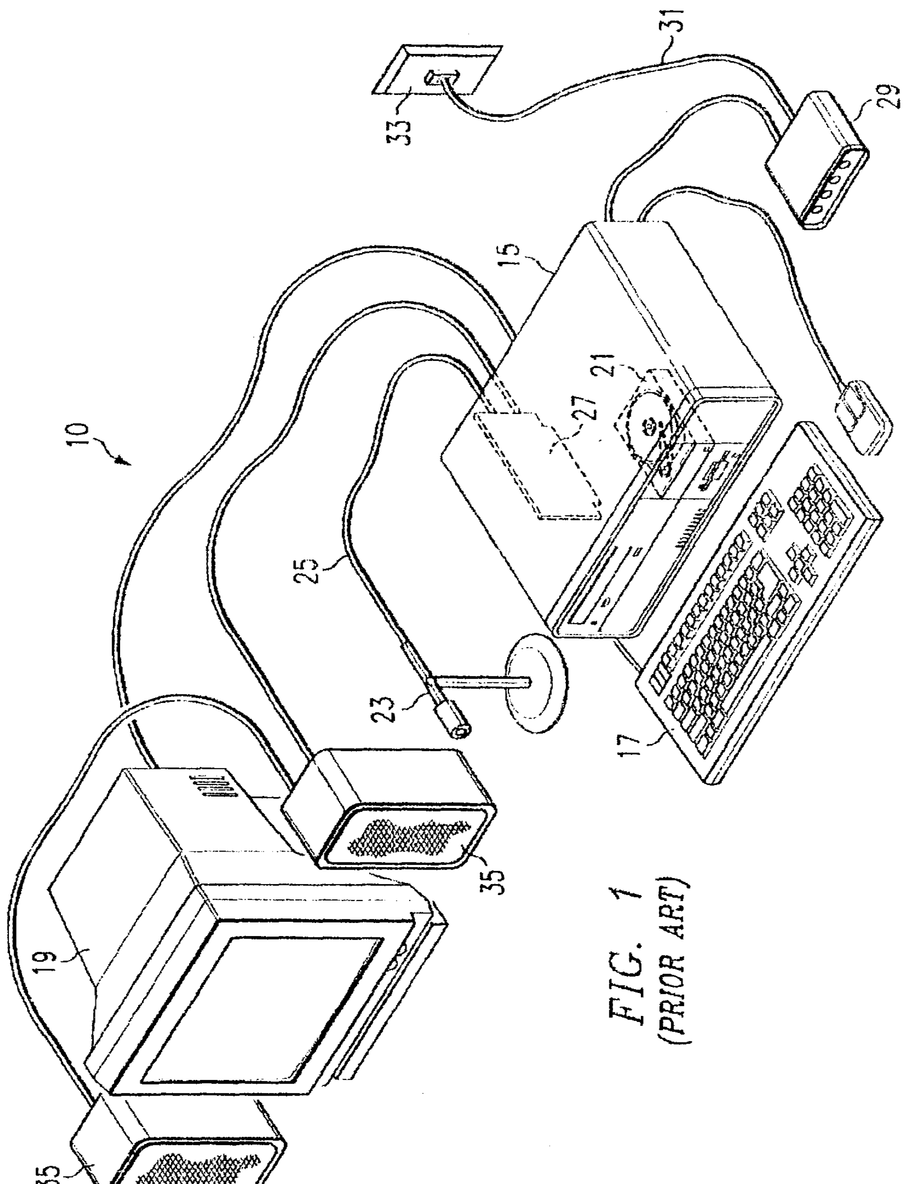
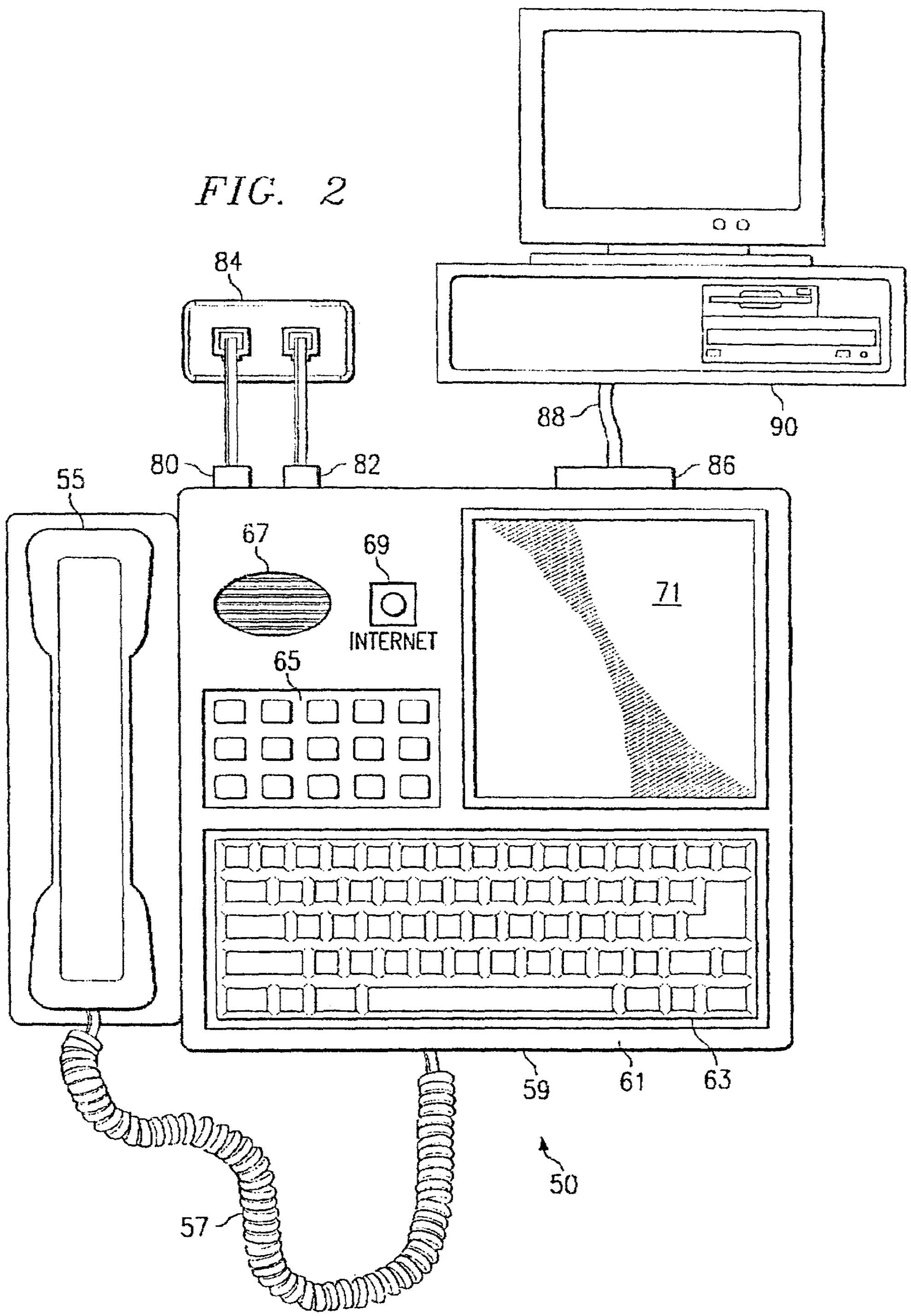



FIG. 1
(PRIOR ART)

SUBSTITUTE SHEET (RULE 26)

FIG. 2




SUBSTITUTE SHEET (RULE 26)

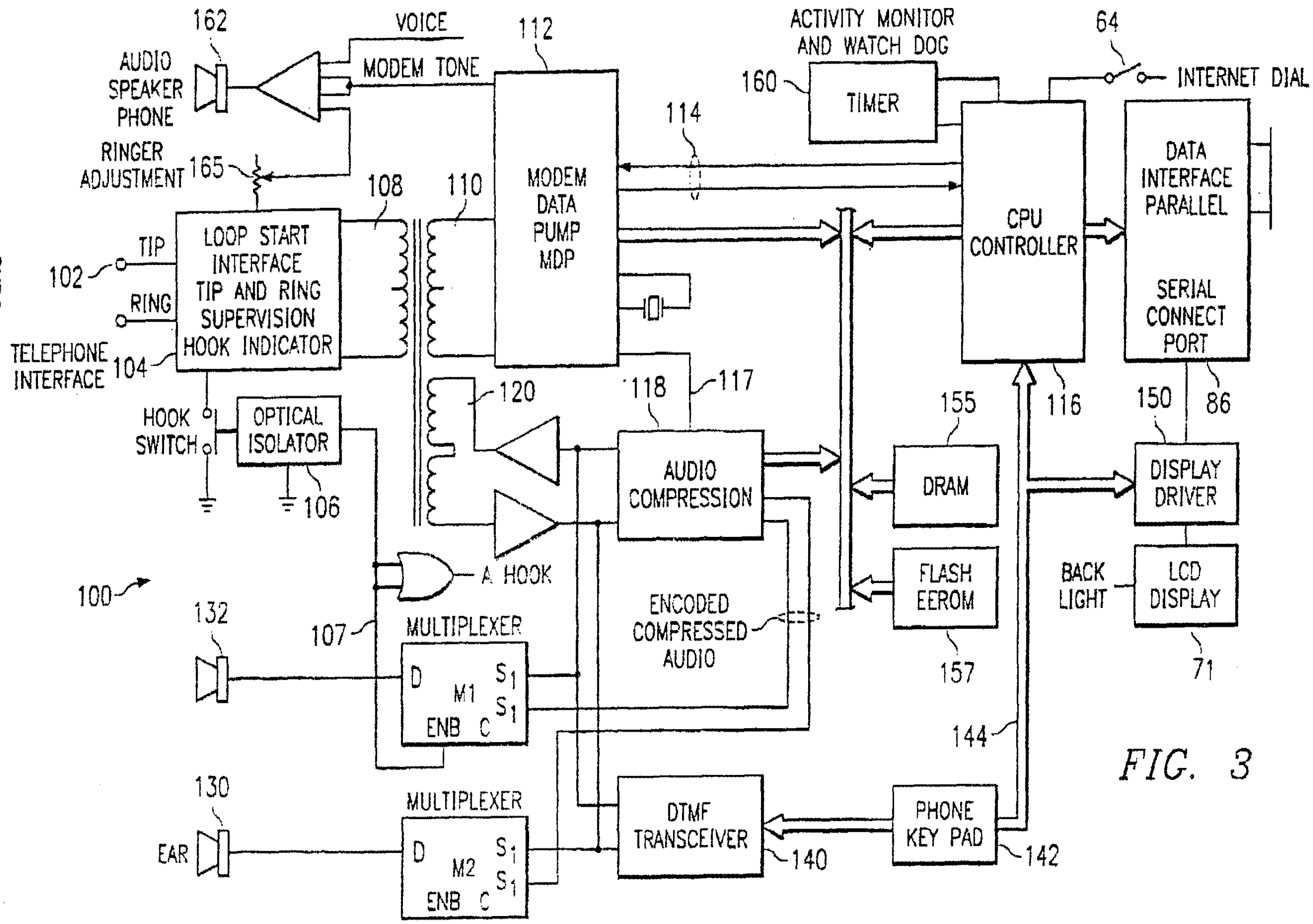



*FIG. 3*

SUBSTITUTE SHEET (RULE 26)

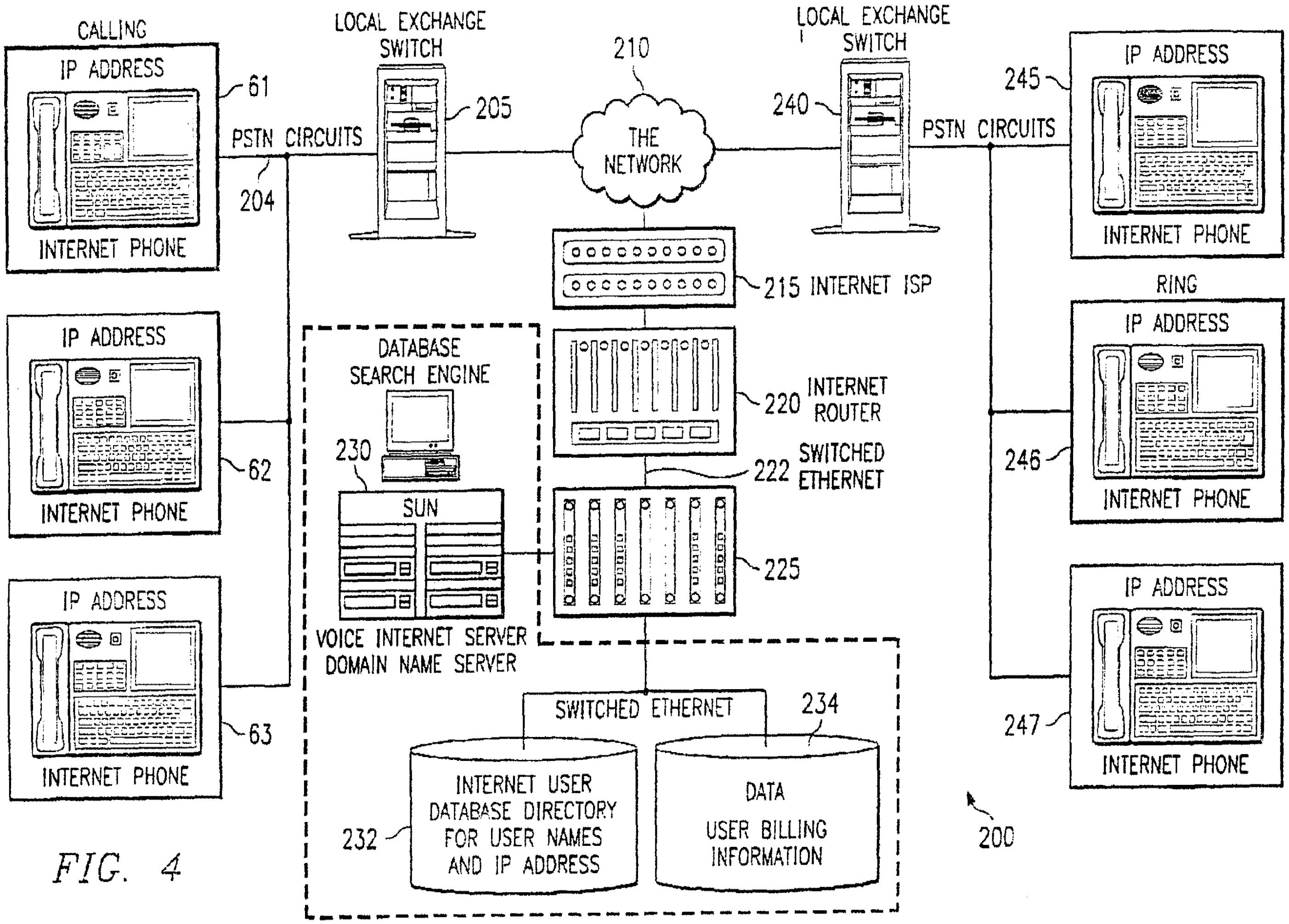

CALLING
IP ADDRESS
INTERNET PHONE
61
PSTN CIRCUITS
204
IP ADDRESS
INTERNET PHONE
62
IP ADDRESS
INTERNET PHONE
63
LOCAL EXCHANGE SWITCH
205
210
THE NETWORK
LOCAL EXCHANGE SWITCH
240
PSTN CIRCUITS
245
IP ADDRESS
INTERNET PHONE
RING
IP ADDRESS
INTERNET PHONE
246
IP ADDRESS
INTERNET PHONE
247
215 INTERNET ISP
220 INTERNET ROUTER
222 SWITCHED ETHERNET
225
DATABASE SEARCH ENGINE
230
SUN
VOICE INTERNET SERVER DOMAIN NAME SERVER
SWITCHED ETHERNET
234
232
INTERNET USER DATABASE DIRECTORY FOR USER NAMES AND IP ADDRESS
DATA
USER BILLING INFORMATION
200

*FIG. 4*

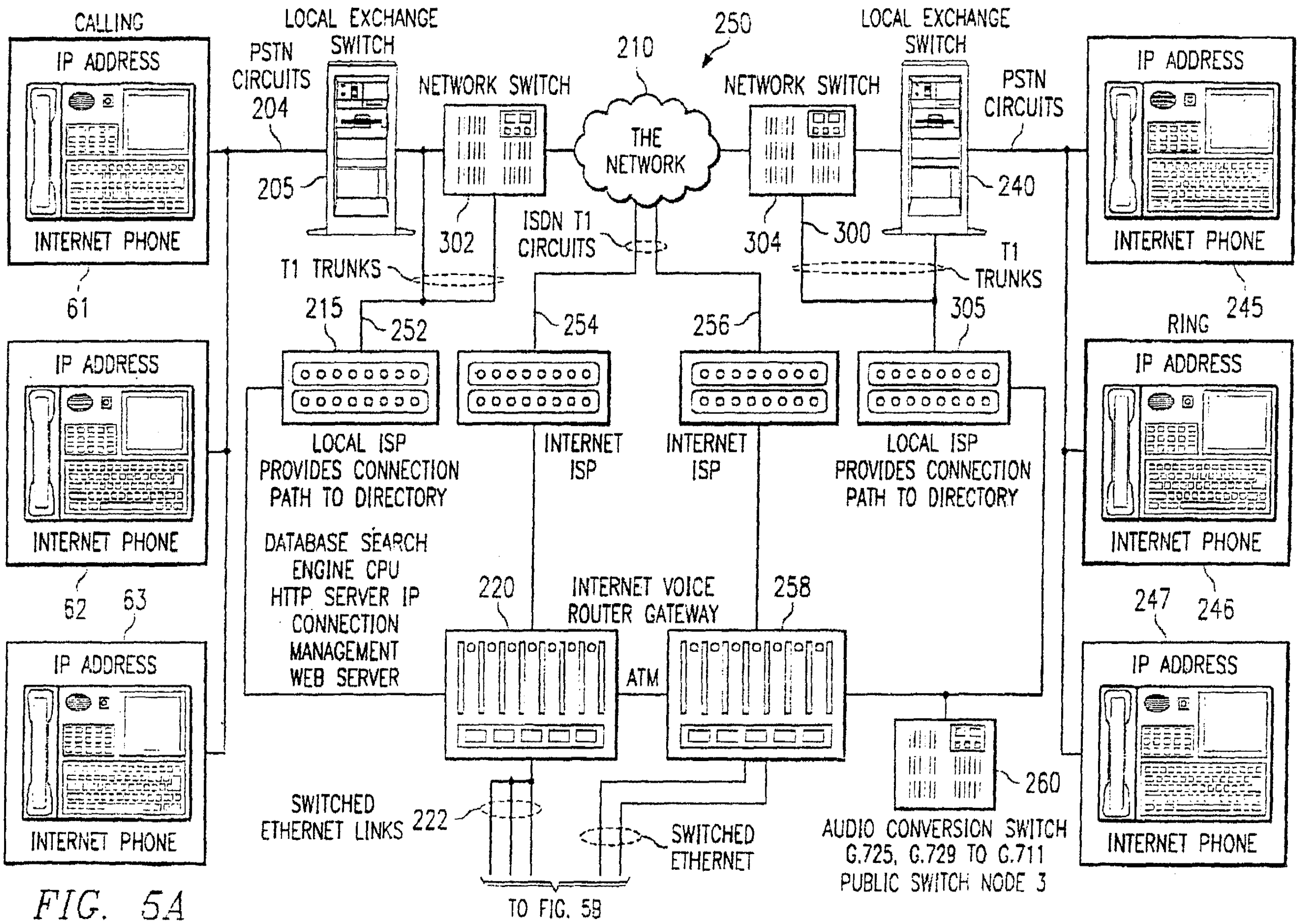

CALLING
IP ADDRESS
INTERNET PHONE
61
LOCAL EXCHANGE SWITCH
PSTN CIRCUITS
204
205
NETWORK SWITCH
302
T1 TRUNKS
215
252
210
250
THE NETWORK
ISDN T1 CIRCUITS
254
256
NETWORK SWITCH
304
300
LOCAL EXCHANGE SWITCH
PSTN CIRCUITS
240
T1 TRUNKS
305
IP ADDRESS
INTERNET PHONE
245
RING
IP ADDRESS
INTERNET PHONE
62
63
IP ADDRESS
INTERNET PHONE
LOCAL ISP PROVIDES CONNECTION PATH TO DIRECTORY
INTERNET ISP
INTERNET ISP
LOCAL ISP PROVIDES CONNECTION PATH TO DIRECTORY
DATABASE SEARCH ENGINE CPU HTTP SERVER IP CONNECTION MANAGEMENT WEB SERVER
220
INTERNET VOICE ROUTER GATEWAY
ATM
258
247
246
IP ADDRESS
INTERNET PHONE
260
SWITCHED ETHERNET LINKS
222
SWITCHED ETHERNET
AUDIO CONVERSION SWITCH G.725, G.729 TO G.711 PUBLIC SWITCH NODE 3
TO FIG. 5B

*FIG. 5A*

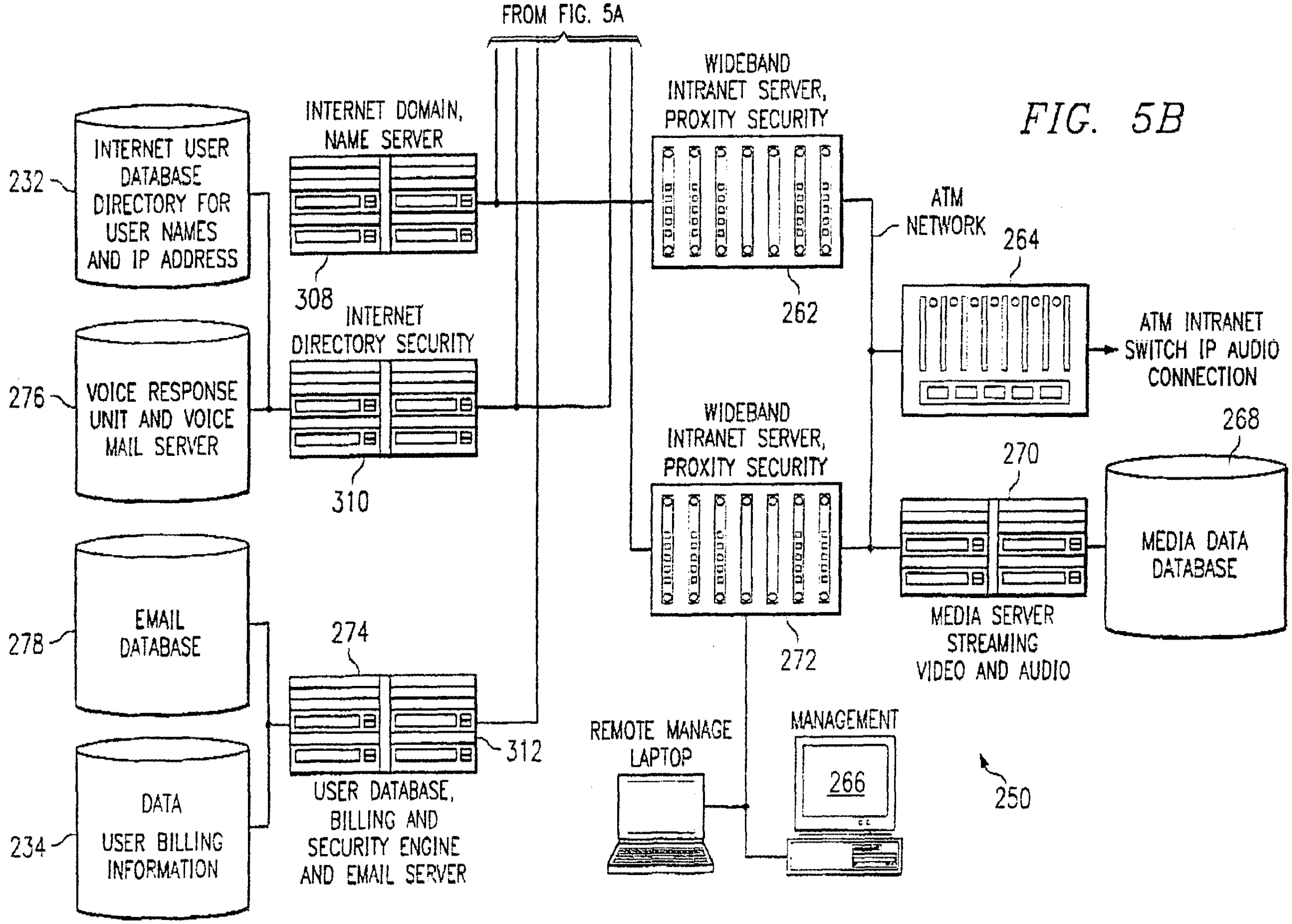

FROM FIG. 5A
INTERNET USER DATABASE DIRECTORY FOR USER NAMES AND IP ADDRESS
232
INTERNET DOMAIN, NAME SERVER
308
WIDEBAND INTRANET SERVER, PROXITY SECURITY
262
ATM NETWORK
264
ATM INTRANET SWITCH IP AUDIO CONNECTION
276
VOICE RESPONSE UNIT AND VOICE MAIL SERVER
INTERNET DIRECTORY SECURITY
310
WIDEBAND INTRANET SERVER, PROXITY SECURITY
272
270
268
MEDIA DATA DATABASE
MEDIA SERVER STREAMING VIDEO AND AUDIO
278
EMAIL DATABASE
274
312
USER DATABASE, BILLING AND SECURITY ENGINE AND EMAIL SERVER
234
DATA USER BILLING INFORMATION
REMOTE MANAGE LAPTOP
MANAGEMENT
266
250

*FIG. 5B*

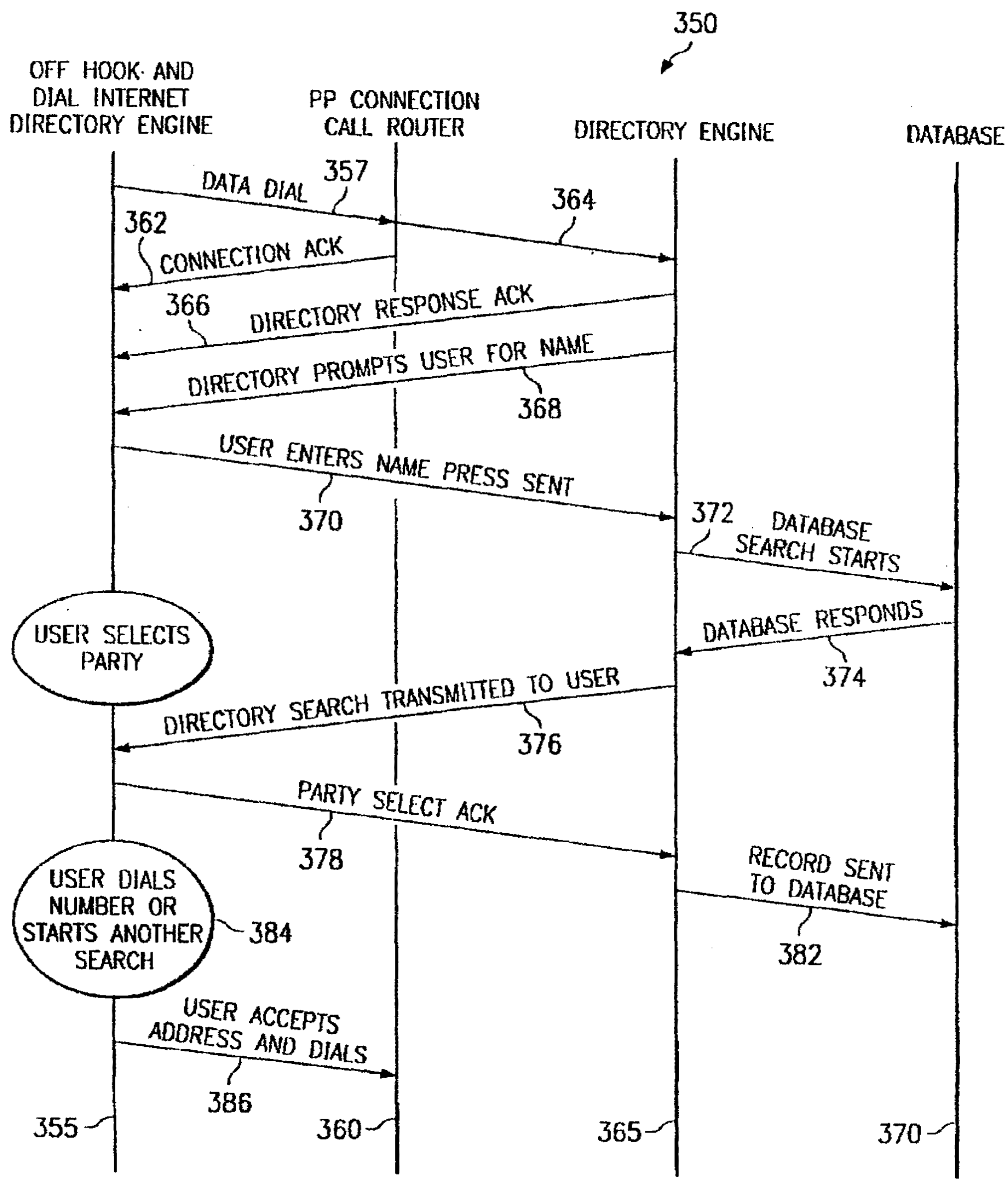

350
OFF HOOK AND DIAL INTERNET DIRECTORY ENGINE
PP CONNECTION CALL ROUTER
DIRECTORY ENGINE
DATABASE
DATA DIAL
357
364
362
CONNECTION ACK
366
DIRECTORY RESPONSE ACK
DIRECTORY PROMPTS USER FOR NAME
368
USER ENTERS NAME PRESS SENT
370
372
DATABASE SEARCH STARTS
USER SELECTS PARTY
DATABASE RESPONDS
374
DIRECTORY SEARCH TRANSMITTED TO USER
376
PARTY SELECT ACK
378
RECORD SENT TO DATABASE
USER DIALS NUMBER OR STARTS ANOTHER SEARCH
384
382
USER ACCEPTS ADDRESS AND DIALS
386
355
360
365
370

*FIG. 6*

# INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/US 97/23816

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04M7/00 H04M1/00 H04M3/50 H04L29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04M H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| E | WO 98 12860 A (JEON CHAN KOO) 26 March 1998<br>see the whole document<br>--- | 1-3 |
| P,X | EP 0 781 016 A (SONY CORP) 25 June 1997<br>see the whole document<br>--- | 1-3 |
| P,X | WO 97 14238 A (INT DISCOUNT TELECOMMUNICATION) 17 April 1997<br>see abstract<br>see figure 2B<br>see page 15, line 34 - page 17, line 3<br>--- | 1-3 |
| A | WO 96 38018 A (KOPONEN HARRI ;KAAKKOLA MATTI (FI); MELEN BJOERN (FI); VAEAENAENEN) 28 November 1996<br>see page 4, line 13 - page 5, line 25<br>see page 10, line 23 - page 13, line 25<br>---<br>-/-- | 1-3 |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

| Date of the actual completion of the international search | Date of mailing of the international search report |
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| 8 May 1998 | 15/05/1998 |
| Name and mailing address of the ISA<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Authorized officer<br>Megalou, M |

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(71) Applicant (*for all designated States except US*): FONEFRIEND SYSTEMS, INC. [US/US]; 3524 Rittenhouse Street, N.W., Washington, DC 20015 (US).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): VAZIRI, Faramarz [IR/US]; 38 Roundout Harbor, Port Even, NY 12466 (US). WIMSATT, John, D. [US/US]; 3524 Rittenhouse Street, N.W., Washington, DC 20015 (US).

(74) Agent: LEDBETTER, James, E.; Watson Cole Stevens Davis, P.L.L.C., Suite 1000, 1400 K Street, N.W., Washington, DC 20005 (US).

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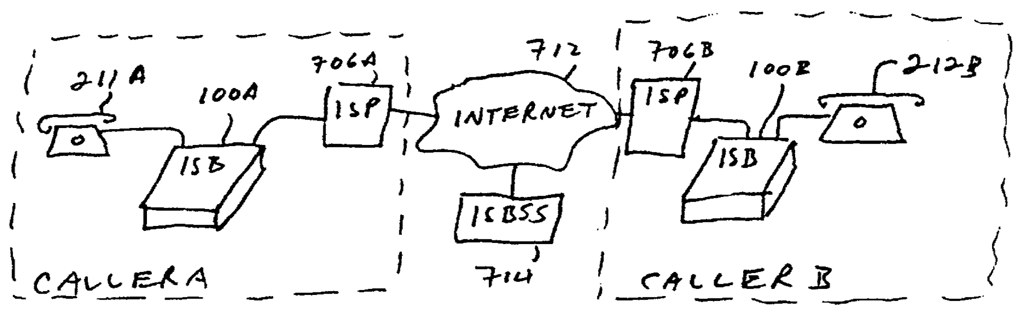


(57) Abstract

An Internet switch box (100) connects between a telephone set and a public switched telephone network (PSTN) line (212), the latter of which is used both for PSTN (702) telephone conversations and for connection to an Internet service provider (ISP) (706). The switch box (100) contains hardware and embedded software for establishing a connection to an ISP (706) and for Internet (712) telephony. When two users, each having an Internet switch box (100A, 100B) connected to the telephone set (211A, 212B), wish to have an Internet (712) telephony conversation, one calls the other over the PSTN (702). When they agree to an Internet telephony conversation, they signal their Internet switch boxes (100), by pressing either buttons (301, 303) on the switch boxes (100) or certain keys on the telephone keypads, to switch to Internet (712) telephony. The switch boxes (100) disconnect the PSTN (702) call and connect to their ISPs (706A, 706B). Once the switch boxes are on the Internet (712), they contact each other through a server (714) which supplies Internet protocol (IP) addresses of switch boxes (100), and the users continue their conversation by Internet (712) telephony. The users can also prearrange to call each other solely by Internet (712) telephony, in which case they do not need to talk to each other over the PSTN (702).

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# INTERNET SWITCH BOX, SYSTEM AND METHOD FOR INTERNET TELEPHONY

## Cross-reference to Related Application

This is a continuation-in-part of U.S. patent application Serial No. 08/810,148, filed February 25, 1997, whose disclosure is hereby incorporated by reference in its entirety into the present disclosure.

## Field of the Invention

The present invention relates to Internet telephony, i.e., placing telephone calls over a specific secondary network, such as the Internet, by way of a standard telephone connection using the Public Switched Telephone Network (PSTN).

## Description of Related Art

The technique of using the Internet to carry on telephone communications is commonly referred to as Internet Telephony (IT) or, sometimes, Voice on the Net (VON). IT is a way to communicate over the Internet that bypasses PSTN toll connections. IT can be advantageous for individuals and businesses that need or want to communicate extensively with others outside of their local calling areas, especially to frequently called numbers.

IT is typically accomplished by what is commonly referred to as Personal Computer-Based Internet Telephony (PCIT). PCIT allows users with properly equipped personal computers to complete long distance telephone calls to one another over the Internet without incurring a toll charge. To do so, the users must have personal computers that are multimedia capable in terms of possessing a sound card, sufficient processing power, a high quality microphone, an adequate modem (preferably 14.4 or faster) and the same specialized software programs, as well as an account with an online service or Internet service provider (ISP) for connection to the Internet via SLIP (the serial-line Internet protocol) or PPP (the point-to-point protocol). Current PCIT techniques are not compatible with shell accounts, which are accounts in which a user logs on through terminal emulation to a remote machine running Unix or the like and accesses the Internet through that remote machine in text mode by typing commands at a prompt.

Several PCIT software packages are on the market. These packages are mutually incompatible; two users wishing to make a PCIT connection must have the same software package. Popular PCIT software packages include those marketed under the names "Iphone" and "Web Phone."

The "Web Phone" software works in the following manner. The users wishing to speak to each other must both be online for the communication to take place, although they can arrange beforehand to be online at the same time.

Both users run the software, and the software packages on both computers seek each other by referring to each other's Internet protocol (IP) addresses. An IP address can be static, meaning that each user is assigned a single permanent IP address, or dynamic, meaning that a user is assigned a different IP address every time that user logs on. If the users both have static Internet protocol addresses, they can simply store each other's IP addresses beforehand. However, many users, including virtually all users of less expensive ISP's and of online services such as America Online, have dynamic IP addresses. Therefore, before the users can connect to each other, they must log onto a common server so that each one can find out the dynamic IP address which has been assigned to the other user. Either way, once the users have each other's IP addresses, the software packages can communicate with each other over TCP/IP (transfer control protocol/Internet protocol) ports 21845, 21846 and 21847.

Sound originating on one end is digitized via the microphone and sound card, compressed, and transmitted to the other end as packets over the Internet using TCP/IP, where the packets are decompressed and converted back into sound via the sound card and speakers.

There are, however, disadvantages associated with the present state of IT or VON. Besides the hardware requirements and the difficulty that many users have with configuring their computers to achieve SLIP or PPP connections to their ISPs, until such time as PCIT vendors can agree on standards, the requirement that both users have the same software to communicate with each other will remain. Not only is the hardware described above expensive, but extensive knowledge of computers and the Internet is also required, making IT intimidating to a majority of the population who would otherwise like to take advantage of this capability. There are other disadvantages to PCIT. Its users need to prearrange a time to call each other because both parties must take proactive measures to connect the call and thereby converse with each other.

Internet Telephony also sometimes refers to a new service being planned whereby individuals or businesses may use or pre-subscribe to a special access number and place their long distance telephone calls by way of a long distance carrier who uses the Internet to carry the calls. This service eliminates most of the disadvantages of PCIT, but also eliminates most of the advantages, in that toll and/or usage type charges still apply.

Devices are known for allowing PCIT by letting users initiate a conversation over the PSTN and switching to IT. Such devices exchange information relating to their IP addresses during the PSTN phase of the call so that the IT phase of the call can be completed. However, in such devices, the modem may be set or initialized twice, once for the PSTN phase of the call to exchange the IP address information and once for the IT phase of the call to connect to the Internet. Setting the modems twice is time-consuming. Also, such devices cannot be used for calls which take place entirely by way of IT, since they have no way of exchanging the IP address related information to locate each other.

Summary of the Invention

It is an object of the invention to allow a user to make telephone calls via the Internet without a need for an expensive multimedia-capable personal computer.

It is another object of the invention to allow a user to make telephone calls via the Internet without a need to configure such a computer for a SLIP or PPP connection to the Internet.

It is a further object of the invention to allow a user to select a route for a telephone call (the Internet, the conventional PSTN, a dedicated network, etc.) and to use a single device for the call regardless of which route is selected.

It is a further object of the invention to provide a device and method for Internet telephony which are easy to use, do not require a computer and offer superb voice quality.

To these and other ends, the present invention is directed to a terminal device or Internet switch box (ISB) for connecting a first telephone set and a second telephone set over a selected one of a primary network and a secondary network, the switch box comprising: primary network connecting means for connecting the first telephone set to the primary network; secondary network connecting means for connecting the first telephone set to the secondary network and for establishing a connection over the secondary network between the first telephone set and the second telephone set; relay means for (i) connecting, when the relay means is in a first state, the first telephone set to the primary network connecting means and for (ii) connecting, when the relay means is in a second state, the first telephone set to the secondary network connecting means; and switching means for receiving a switch-over command to switch from the primary network to the secondary network and for controlling, in response to the switch-over command, (i) the relay means to disconnect the first telephone set from the primary network connecting means and to connect the first telephone set to the secondary network connecting means and (ii) the secondary network connecting means to establish the connection over the secondary network between the first telephone set and the second telephone set.

A relatively inexpensive interface device, referred to as an Internet switch box (ISB), is connected to or integrated within the telephone. While the user must possess access to the Internet either directly or via an Internet Service Provider (ISP) in order to use the ISB, the user will not be subject to toll charges other than those incurred using the PSTN to establish the Internet telephone call. The user does not need to understand how a computer works or how to use any PCIT software, since the ISB can be preprogrammed to dial an ISP and to connect via SLIP or PPP. The user need only know how to dial the call using normal PSTN dialing procedures and then simply switch the call to an Internet connection, if available and desirable. Other than the user pressing a button (either on the ISB or telephone keypad) to initiate the Internet telephone call, the ISB takes care of all connection procedures (i.e., handshaking) necessary to set up and maintain the Internet telephone call. While both parties must possess an ISB in order to take advantage of the ISB's IT capabilities, only one party needs to initiate the telephone call in order to establish the Internet connection, so that prearrangement is not required.

Advantageously, the selection among networks may be among the PSTN, selected proprietary networks, or the Internet. It should be noted that the PSTN utilizes circuit switching techniques whereas, for instance, the Internet makes use of packet switching. Circuit switching was specifically designed and is best for analog voice transmissions, whereas packet switching was designed and is best for digital data transmissions. Regardless, either type of switching may be employed for voice or data. The calling party uses the PSTN to first establish the connection between calling and called parties, and then the two parties decide whether or not to use their ISB's to re-establish the connection via a secondary network such as the Internet. The users will consider convenience, cost and connection quality in making this choice. If the telephone call is to another party in the same local calling area, of short duration, or one where, regardless of cost, the stability and voice quality of the connection are essential, then the users typically opt to stay on the PSTN connection and not seek to switch to the Internet. Otherwise, the potential cost savings of simply switching to an Internet connection make doing so preferable.

As indicated, an ISB may be incorporated into a telephone or be a standalone adjunct device connected between the telephone and the telephone line. Additionally, ISB's may be associated with facsimile machines, wireless telephones and multiple line telephone systems, such as key telephone and Private Branch Exchange (PBX) systems, and operate to provide multiple users of such Customer Provided Equipment (CPE) the ability to designate the secondary network handling of their toll calls. According to one embodiment, the ISB will set up a secondary network or Internet telephone call after the PSTN connection has been established and in response to a command to do so by its user(s) as described above. In an alternative embodiment, the ISB may be configured to establish a connection over a secondary network automatically unless commanded not to prior to the call being placed. In either case the called telephone can answer or simply ring before the telephone call can be switched to a secondary network or the Internet. As such, the ISB does not interfere with accepted and customary PSTN procedures in that the PSTN portion of the telephone call is billable only if there is an answer by a live person or an answering machine or voice mail service.

In order to establish a secondary network or Internet connection via the ISB, the user will first dial the PSTN telephone number of the intended call recipient. Once the called telephone is answered, which is a billable PSTN telephone call of short duration, both parties initiate, via a simple key stroke, the switch to the secondary network. The two ISB's disconnect the PSTN call, and each initiates its own call to the other via the secondary network. If the secondary network is the Internet, the connection typically is by way of an Internet Service Provider (ISP) which can be reached, advantageously, by a toll-free telephone call enabling access to the user's Internet service account which, advantageously, has unlimited use or use charges in an amount much lower than the expected PSTN charges. The two ISB's possess information (i.e., addresses, passwords, etc.) necessary to re-connect the telephone call via the secondary network. Each ISB can be programmed to provide call progress tones or to play pre-recorded messages, music, etc., while the users await reconnection. If the call cannot be connected via the secondary network due to access problems at the ISP or otherwise, then each party is so informed by a recognizable audio signal such as a busy signal or a voice recording. Either or both parties can, by pressing appropriate keys, retry their connection via the Internet or reconnect the telephone call over the PSTN. This capability is somewhat analogous to the redial capability on many conventional telephones. Should two parties seek to avoid PSTN charges altogether, they may use this same capability to do so via prearrangement. In so doing, each party need only input the other party's telephone number in addition to pressing the appropriate buttons on the ISB or telephone keypad. Regardless, once the call is connected via the secondary network or the Internet, the parties terminate the call by hanging up, as with any PSTN call.

The present invention thus implements an embedded approach to IT which offers the following advantages. The use of ISB's allows low-cost, easy-to-use, embedded Internet access for telephones. Lower cost is achieved because no PC's are required. Users, many of whom would prefer not to have to configure a PC for Internet access, are offered a familiar PSTN approach which can identify a called party by that party's existing telephone number. This approach also preserves the major advantage of IT, namely, the use of low-cost Internet bandwidth.

While the invention is intended primarily for use with single-line analog telephone sets, it can be adapted for use with other telephone systems, such as DID PBX (direct-in-dial private branch exchange) and Centrex service and with analog or digital mobile telephones such as cellular telephones and PCS (personal communication service) telephones. Also, while the ISB can be built to access the ISP through a dial-up connection, it can alternatively be built to access the ISP through another connection, such as an ISDN (integrated services digital network) connection or a cable modem connection.

Brief Description of the Drawings

The preferred embodiment will now be described in detail with reference to the drawings, in which:

Figure 1 is a flow chart depicting the functional organization of the ISB;

Figure 2 is a block diagram of an embodiment of the ISB;

Figure 2A shows a software architecture implemented in the hardware of Fig. 2;

Figure 2B shows an alternative design of an ISB;

Figure 3 shows a front panel view of the ISB;

Figure 4 shows a rear panel view of the ISB;

Figure 5 shows a flow chart of the steps involved in placing a call between two ISB users;

Figure 6 shows a flow chart of operations performed by one of the ISB's during the call of Figure 5;

Figures 7A-7E show the connections between one or more ISB's and other telephony components during various calling operations;

Figure 8 shows a flow chart of the operational states assumed by the ISB's during a PSTN-to-Internet call;

Figure 8A shows a flow chart of the dynamic adjustment performed during the Internet phase of a telephone call;

Figure 9 shows a connection between an ISB and a help desk;

Figure 9A shows a flow chart of operation of an ISBSS, which is a server used to complete calls;

Figures 10A and 10B show a code listing for the ISBSS;

Figure 11 shows a state diagram of the ISBSS;

Figures 11A-11E show data structures exchanged between the ISBSS and an ISB;

Figure 11F shows an output of a monitoring process performed by the ISBSS;

Figure 11G shows an error log kept by the ISBSS;

Figure 12 shows a system defined by multiple users' ISB's, the PSTN, the Internet, the help desk, the ISBSS and various other servers; and

Figure 13 shows an IT standard which may be implemented with the present invention.

Detailed Description of the Preferred Embodiment

According to a preferred embodiment, the ISB is capable of performing three major tasks: (1) establishing voice telephone calls via the Internet; (2) sending/receiving voice messages via Internet based E-Mail; and (3) interfacing with Internet Audio Servers.

During the execution of each task, one of the following five modes of operation can be assumed by the ISB:

I. Programming Mode: The ISB can be programmed locally or remotely by a telephone keyset or external keyboard for its desired operation.

II. PSTN Voice Mode: The ISB is transparent and does not interfere with voice communications between two parties involved.

III. PSTN Data Mode: The ISBs can exchange data via in-band signaling or otherwise.

IV. Internet Voice Mode: UDP packets are exchanged to carry voice over the Internet ("UDP" stands for "User Datagram Protocol," a protocol which allows applications to send messages to one another).

V. Internet Data Mode: TCP or UDP packets are exchanged to carry information other than voice, such as signaling or IP address resolution.

These modes of operation are realized by invoking a collection of resources in the ISB 100 which are under control of the ISB's application module 101. These resources are shown in Figure 1 and described below:

Telephone Set Controller (TSC) 102 is a module which controls all signaling activities related to a "Plain Old Telephone" (POT), i.e., on-hook, off-hook, hook-flash, pulse or tone dialing, ringing, ringing trip detection, etc.

Loop/Start (L/S) Line Controller (LLC) 103 is a module which controls all signaling related to a loop start telephone line, i.e., ring detection, line seizure, hold, loop current detection, pulse and tone dialing, etc.

Modem/Facsimile Module (MFM) 104 is a module which provides a modem and facsimile engine to transmit digital data over PSTN line. The baud rates of the modem/fax are determined by data exchange requirements.

Voice Compander (=compresser and expander) Module (VCM) 105 is a module which compresses the linearly sampled voice into low bit rate digital voice suitable for digital telephone applications. The expander part of the module performs the reverse operation.

Tone Generators and Decoders (TGD) 106 is a module which produces and detects all call progress (e.g., dial, busy, special, etc.) and signaling (e.g., dual-tone multifrequency or DTMF, multifrequency or MF, etc.) tones.

Voice Players and Recorders (VPR) 107 is a module which records and plays voice prompts under the direction of the ISB.

Digital Switching Matrix (DSM) 108 is a module which enables the different modules (i.e., TSC, LCC, TGD, VPR, etc.) can be connected together via buses 111 and 112.

Signal Processing Services (SPS) 109 is a module which handles signal processing services such as echo cancellation, speech recognition, pitch adjustment, etc.

Network Connection Module (NCM) 110 is a module which handles all digital networking communication between the ISB and other external digital sources such as the ISP, another ISB, various Internet resources and servers, etc. are handled by this module.

Application Module (AM) 101 is a module which provides the logic flow required to execute the above mentioned tasks.

The following describes several of the operations of the ISB:

1. Programming the ISB: The user uses the telephone keypad and menu button 301 on front panel 302 of the ISB (Fig. 3) to enter the programming mode (local or remote). The ISB guides the user through a menu-driven procedure to program the ISB by using voice prompts, guide tones or both. The user inputs the desired information by entering a code with the telephone keypad corresponding to each character to be entered; the instruction manual for the ISB can include a table of two-digit codes for all digits, all capital letters, all small letters (thus allowing case-sensitive information to be entered with ease and accuracy), and any punctuation

marks to be used. The ISB can be programmed externally (remotely) as well; external programming can be used to input user-specific data and to update the ISB. Local programming is especially useful when the user changes ISPs.

Programming can also be accomplished by connecting the ISB to a computer such as an IBM-compatible PC via a serial link or another appropriate link. The programming can be done by entering ASCII commands from the PC through a standard terminal-emulation program or by software written specifically for this purpose. During manufacture, the ISB is programmed with its factory settings through a connection to a computer.

2. Telephone call: The calling party picks up the telephone (goes off-hook) and dials the telephone number of the called party. The ISB monitors and stores the digits dialed. The called telephone rings and is answered by a live person, answering machine or voice mail service. If the called telephone is answered by a live person, the two parties decide whether or not it is appropriate to switch to the Internet. The parties may initiate the switch to the Internet by pressing the appropriate code on the telephone keypad or Internet button 303 in the ISB itself. The ISBs of the calling and called parties then disconnect the PSTN connection (this step is not necessary if the ISBs have multi-line capabilities) and dial their respective ISPs so that each ISB is connected to the Internet. While each ISB connects to the Internet, the person using the ISB hears progress tones, recorded music, or the like.

Once the ISBs are connected to the Internet, they connect to the server, unless (as is rather unlikely) each party knows that the other party has a static IP address and has that static IP address on file. Each ISB sends its telephone number and IP address to the server so that the server has a current IP address corresponding to each telephone number. Each ISB communicates the other party's telephone number to the server to retrieve the other party's IP address. Once each party knows the other party's IP address, the Internet telephone connection begins, and the ISBs send voice packets to each other. The ISBs can also resolve each other's IP address in other ways, such as through e-mail (POP3) servers.

Of course, two users are not precluded from arranging to call each other on the Internet at a certain time, in which case they avoid PSTN charges altogether. However, the use of the ISBs described above offers additional flexibility in that users can choose to prearrange their Internet calls or initiate them over the PSTN.

3. Sending and receiving voice mail messages: The user presses menu button 301 or otherwise issues a command to summon the menu and follows the prompts to send and receive messages. The digitized voices for such messages are sent as binary attachments to e-mail messages; one ubiquitous standard for such binary attachments is called MIME (multimedia Internet mail extensions). Both parties should have e-mail access. If the calling party does not already know the called party's e-mail address, the ISBSS or another server can correlate telephone numbers with e-mail addresses.

The ISB have the capability to dial in to check the e-mail for voice messages periodically. If a voice message is waiting, the ISB can so indicate by providing a flashing LED, by emitting a special tone when the user picks up the telephone, or the like.

4. Internet Audio Server (IAS) calls: These are calls made through the ISB to access IASs, or Internet audio servers, which are Internet servers (such as Web or FTP (file transfer protocol) servers) configured to provide audio information. The user picks up the telephone and presses the menu button 301 on the ISB. The menu system uses voice prompts to prompt the user to access different IASs. The ISB then accesses the selected IAS either by telephone or by dialing the ISP and connecting to the IAS over the Internet. The ISB can resolve the IP address

of an IAS either by accessing the server described above or by accessing a conventional domain-name server (DNS), which is a server for correlating IP addresses and domain names such that the DNS provides an IP address when given a domain name. Once an IAS is known, the ISB can store the IP address, since servers provided for access by the general public normally have static IP addresses.

5. ISB special server: As noted above, a server is provided to allow the users of two ISBs to resolve each other's IP addresses. Such a server is known as an ISB special server (ISBSS), and it correlates telephone numbers to IP addresses. The ISBSS can look up an IP address for an ISB which has previously accessed the server and provided information correlating its telephone number and IP address. The ISBSS does this by searching by the telephone number, or the least significant digits of the telephone number, provided by another party wishing to access that ISB. The ISBSS also uses telephone numbers to find e-mail addresses and possibly also the IP addresses of IASs. With the ISBSS, the ISBs do not have to exchange information concerning their IP addresses directly during the PSTN phase of a telephone call.

The ISBSS can also collect and report transactions, statistical data about attempts, completions, etc. by type of call request and customer, for engineering and marketing purposes. The requirements for interfacing, processing and data storage with a computer based server such as the ISBSS will be readily understood by those skilled in the present state of the art. A fuller description of the ISBSS will be set forth below.

6. Compatibility with call waiting, caller ID, and other enhanced telephone features: According to one embodiment of the ISB, call waiting must be inactive to assure Internet call connection continuity. A disable code can be programmed to de-activate this feature when Internet telephone calls are in process. It is presumed that users who are on a long distance call

do not want to be disturbed. Such disable codes are known in the art; for example, it is known to configure communication software to disable call waiting by dialing a code such as *70 and pausing before every call. Another embodiment of the ISB not only allows call waiting to function but also incorporate caller ID and other premium telephone services. For example, an ISB can have integrated caller ID and can even indicate whether the caller has an ISB, e.g., by searching by the telephone number through the ISB's database of completed calls.

These and other operations are implemented on hardware and software which will now be described in detail. According to a preferred embodiment, the ISB is implemented by realizing the described modules by way of an existing personal computer or by repackaging the necessary personal computer capabilities into a commercially viable design. In the latter case, the ISB need not include those hardware or software capabilities which are not relevant to the functions which the ISB is expected to perform; therefore, the hardware and software can be radically simplified from those of a personal computer. In particular, the ISB can be implemented in hardware and software compatible with MS-DOS, rather than in the considerably more complicated and expensive hardware and software associated with operating systems such as Windows 95 or Windows NT. In the alternative, a design based on a digital signal processor (DSP) can be employed. Various elements of any designed embodiment such as the modem and vocoder functions can be implemented via hardware or software equivalents. Those skilled in the art are familiar with the computer telephony modules and software libraries which can easily implement the disclosed modules. The following describes a commercially efficient approach, and Figure 2 shows a schematic illustration of this preferred embodiment.

The ISB includes PC-compatible microcontroller (microprocessor) 201, such as an Intel 80186 processor or an equivalent. Microcontroller 201 includes integrated timers, direct memory access (DMA) channels, serial links and interrupt handlers and is supported by a memory system 202 including, for example, ROM, SRAM, flash memory, or EEPROM. Microcontroller 201 and memory system 202 together form the main processing unit for the ISB. Memory system 202, besides providing working memory for the operation of the ISB, also stores such code as is needed to operate the ISB. For example, memory system 202 includes code for establishing an Internet connection; such code is analogous to a Winsock dialer on IBM-compatible PCs.

An internal DC-to-DC power converter 213 provides the proper voltages to the various components within the ISB. An appropriate external AC-to-DC adaptor interfaces the ISB to the available AC power alternatives found in the U.S. and elsewhere.

The modem 202 may be implemented most advantageously via a hardware modem or modem chip which is connected to the microcontroller 201 and the Loop Start Line Controller 208 and data access arrangement (DAA) 209, both of which are described below. Modem 202 can be a Rockwell 14.4 modem or any other suitable modem, although it should preferably be capable of a speed of at least 14.4 and should also preferably be upgradeable as new modem standards emerge.

The vocoder 204 may be most advantageously implemented via hardware which is connected to the microcontroller and which has its own SRAM 214. The vocoder provides low bit rate voice compression and decompression and interfaces the Telephone Set Controller 205.

The Telephone Set Controller 205 includes a Subscriber Line Interface Circuit (SLIC) 206 and a CODEC 207 which is, advantageously, connected to the vocoder. CODEC 207 allows SLIP or PPP connection to the Internet.

Loop Start Line Controller 208 includes a Data Access Arrangement (DAA) 209 and is connected to the modem 202 and the telephone line 212.

A 2 FORM C relay 210 is provided, as illustrated in Figure 2, to connect the telephone 211 to either the telephone line 212 or the Telephone Set Controller 205. When telephone 211 is connected to telephone line 212, the ISB functions as a passive pass-through device. When telephone 211 is connected to telephone set controller 205, communication between telephone 211 and telephone line 212 (i.e., between telephone 211 and the outside world) passes through and is handled by the circuitry of the ISB, including telephone set controller 205, vocoder 204, microprocessor 201, modem 202 and loop start line controller 208.

Telephone 211 should preferably not be the sort of telephone which has its own power source (e.g., cordless telephone or integrated telephone and answering machine) or which manipulates its signaling (e.g., speaker phone with echo suppression technology).

Microprocessor 201 executes the software architecture shown in Fig. 2A. Software architecture 2A01 is based on a space-efficient embedded operating system such as ROM DOS 2A03, which includes application component 2A05 and maintenance component 2A07. Maintenance component 2A07 interacts with the following drivers. Telephone interface driver 2A09 allows the software to interact with telephone set 211. G.723 audio CODEC driver 2A11 interacts with maintenance component 2A07, telephone interface driver 2A09 and TCP/UDP driver 2A13. TCP/UDP driver 2A13, IP driver 2A15 and PPP driver 2A17 serve as modifiable, embedded networking software for packetizing data and allowing communication with the Internet; thus, they correspond to a Winsock driver on a conventional PC running Windows 95, 98 or NT. UART/modem driver 2A19 and telephone interface driver 2A21 allow communication with telephone line 212. ("UART" stands for "Universal Asynchronous Receiver and Transmitter" and refers to a chip used to interface a modem with the rest of the hardware of a computing device.)

The software can be a combination of commercially available software adapted for the ISB and proprietary software written specifically for the ISB. However, the ISB can use commercial, modified commercial or proprietary software or any combination.

As noted above, the hardware of the ISB can alternatively be implemented with a DSP chip. Such an alternative implementation is shown in Fig. 2B. As seen in this figure, ISB 2B01 includes microprocessor 2B03, which can be like microprocessor 201 of the embodiment of Fig. 2. Microprocessor 2B03 communicates via data and address buses 2B05 with two 512 kB EEPROM's 2B07 and a 512 kB RAM 2B09 which store the program code, data for the operation of the ISB (which will be described in detail below) and the like and provide working memory for the operation of the ISB. Microprocessor 2B03 also communicates via data and address buses 2B05 with modem or modem chip 2B13, which can be the same as modem or modem chip 202 of the embodiment of Fig. 2, and with DSP chip 2B11. DSP chip 2B11 performs compression and decompression and thus performs functions like those of vocoder 204 of Fig. 2. Modem 2B13 and DSP chip 2B11 communicate via telephony interface 2B15 with telephone set 211 and PSTN line 212. Microprocessor 2B03 also communicates with serial flash memory 2B17, which stores device data, server data and the like, and with front panel 2B19, which has LEDs (to be described in detail below with reference to Fig. 3) for communicating the status of the ISB to the user.

The ISB, whether constructed according to Fig. 2 or Fig. 2B, is packaged in an enclosure measuring approximately 7 inches by 7.4 inches by 1.4 inches and having slots sufficient for ventilation. A fan may also be provided if needed. The components shown in Figs. 2 and 2B are mounted on a printed circuit board.

The hardware and software used in the ISB can be analogized in the following manner to the hardware and software of a known PC used for IT:

| Function | Known PC | ISB |
|---|---|---|
| Digitize voice | Sound card | CODEC |
| Compress data | Compression algorithm executed on CPU | Vocoder or DSP chip |
| Packetize data | Winsock | portable networking software |
| ISP access | modem | modem chip |
| operating system | Windows 95, 98 or NT | ROM DOS |
| CPU | Pentium ≥ 133 MHz | Intel 80186 |
| user interface | monitor and keyboard | telephone keypad, earpiece |

Figure 3 shows a front or top view of an ISB. Front or top panel 302 may include a logo 305. Status indicator LEDs 304, 306, 307 and 311 may be provided. Three of these LEDs may be used to indicate whether the power is on or off, the status of an Internet call attempt and whether any messages are waiting. The fourth can be used in various ways, such as to indicate whether the menu feature is in use or whether an upgrade to the ISB software is available (in which case the software can be upgraded in a manner to be described below). Of course, other configurations of LEDs can be used, as can other interfaces such as an alphanumeric LCD display.

Buttons 301 and 303 may be used as already described. As an alternative to the buttons, the ISB can be configured to listen to the connection from telephone 211 to detect an off-hook state of telephone 211 and to monitor the digits dialed. If the first digit dialed after the telephone is picked up is a pound sign ("#"), the ISB knows that the user wants to access the ISB's menu system. The ISB generates a voice prompt to prompt the user to select one of the following options by way of the keypad on telephone 211:

| Digit | Action |
|---|---|
| 1 | Reconnect or retry a call via the Internet |
| 2 | Make a new call via the Internet |
| 3 | Listen to voice messages |
| 4 | Send a voice message |
| 5 | Make an Internet test call (to test both the operation of the ISB and the ISP access) |
| 6 | Program the ISB |
| 7 | Upgrade the ISB |
| 8 | Make an off-net call |
| 9, 0 | Reserved for future use |

If the menu system is accessed in this manner, the menu button is unnecessary. Also, because making an Internet call is a menu option, the Internet button is also unnecessary. Thus, the hardware and user interface of the ISB are simplified, and the ISB has fewer mechanically actuable components to break. Once a user becomes familiar with the menu system, he need not wait for the voice prompt, but instead can simply pick up telephone 211 and dial # and an appropriate digit to perform the function desired. Also, to cancel any operation, the user can simply hang up.

To produce the voice prompts, the ISB can store sound clips in an appropriate format in memory system 202 and play them to the user through telephone 211. For example, one such sound clip can be a recording of a voice saying, "To reconnect or retry your telephone call on the Internet, press 1." Just as conventional software can be supplied in different language versions, the ISB can be supplied in different language versions with different stored sound clips.

To cancel or start over, the user hangs up. If the ISB locks up, it can be reset by unplugging and reconnecting the power supply. Alternatively, the ISB can be equipped with a reset button like those on known PCs.

Fig. 4 shows the back or bottom view of an ISB. Back or bottom panel 402 can include telephone jack 404 for connection to telephone 211, telephone jack 406 for connection to telephone line 212, optional port (serial, parallel, universal serial bus (USB), etc.) 408 for connection to another device such as a PC, and power jack 410. An AC-to-DC power adapter can be plugged in to power jack 410; the cumulative effect of the AC-to-DC power adapter and the DC-to-DC power converter is to supply a +12-volt DC supply to the circuitry of the ISB. Alternatively, the ISB can contain all of the power conversion circuitry internally, in which case back or bottom panel 402 can include a power cord to be plugged directly into a wall outlet. Also, if the ISB is intended for use with a connection other than to the analog PSTN, such as a connection to an ISDN line or to a cable modem, jack 406 can be modified accordingly. Optional port 408 can be used for any operation involving an exchange of data between the ISB and some other device, such as programming and testing the ISB at the factory and for attachment to some peripheral such as a digital camera for videophone service or a caller ID unit.

It will be readily apparent from Fig. 4 and the description thereof set forth above that a user can easily install the ISB. The user simply plugs telephone 211 into jack 404, a cord from telephone line 211 into jack 406 and a power adapter into power jack 410 to supply power from a wall outlet. Once the ISB receives power, it undergoes a POST (power-on self test) routine, such as that performed by a conventional PC. During the POST routine, all LED's light up for a predetermined period of time, such as seven seconds, to inform the user that the ISB is working correctly and is in the POST routine. The ISB can also be configured to give an error beep or an error indication through the LEDs if the POST routine fails, as is also conventional in PCs. Once the POST routine is completed, the ISB enters standby mode, in which it monitors signals from telephone 211 to detect when the telephone is picked up and which digits, if any, are dialed.

The ISB includes a housing that can be desk- or wall-mounted. A premises wiring pattern and the number of telephones sharing the same telephone line will dictate the ISB's most advantageous installation.

Any or all components of the ISB which rely on code for their operation can be made software-upgradeable. For example, the modem can be software-upgradeable as modem technology advances and as standards such as the recently announced 56K standard are implemented, and the portions of the memory system containing code for the operation of the microcontroller can be software-upgradeable to allow for the H.323 Internet telephony standard. When the user issues a command to upgrade the software (e.g., by dialing # to access the menu and then by dialing 7), the ISB connects via the user's ISP and the Internet to an upgrade server to download and install the latest version of the ISB software, an operation which typically takes four to six minutes. The previous version of the software can be stored to allow the upgrade to be undone locally with no need for access to the upgrade server; to undo the upgrade, the user dials "*0#". For example, in a 512k EEPROM, 192 kB can be used for DOS and the BIOS (basic input-output system, a set of routines which allow a microprocessor to communicate with other hardware), 384 kB for the current version of the application software, 192 kB for a scratch buffer, and 384 kB for the previous version of the application software. At the factory, the ISB is provided with two copies of the same version of the software; one of these copies is overwritten in the first upgrade, while the other is available to undo the first upgrade. Some upgrades may require assistance from the help desk (to be described below), such as those allowing new extra-cost features.

Each ISB stores information regarding that ISB. Such information can include all information necessary for connecting to the Internet (e.g., telephone number, user I.D. and password for logging onto the ISP). The information can also include a record of other ISBs with which the ISB has interfaced, including data for each other ISB such as the telephone number and the static IP address if any. The oldest and least used entries can be purged periodically.

More specifically, the ISB stores device, server, billing, and owner information and a friends directory. The device information is typically programmed into the ISB at the factory and includes the serial number, the manufacturing date, the hardware version, the software version, and the feature key, which identifies those features which the ISB implements. The server information includes the IP addresses for the various servers which the ISB needs to access, such as the primary and backup ISBSSs. The owner information includes the telephone number, the ISP access telephone number, any scripting required to log onto the ISP, logon name and password, the domain names or IP addresses for the SMTP and POP servers for e-mail, the e-mail address, and the e-mail password. The SMTP server implements the simple mail transfer protocol (SMTP) for sending e-mail, while the POP server implements the post office protocol (POP) for receiving e-mail. Many ISPs use the same server for both protocols. Other mail protocols exist and can be used instead. The server and owner information can be programmed locally by the user or over an Internet connection by an agent at a help desk, which is described in detail below. The friends directory is maintained automatically and in run-time and has a data structure like that shown in the following table:

| Record # | Serial # | Telephone # | E-mail address | Counter |
|---|---|---|---|---|
| 1 | 100011 | 202-555-0102 | hisname@someserver.com | 25 |
| 2 | 100021 | 703-555-0103 | hername@anotherserver.edu | 11 |
| *** | *** | *** | *** | *** |

| | | | | |
|---|---|---|---|---|
| 99 | *** | *** | *** | *** |

The counter is increased by one for each conversation with a particular person. When the number of entries to be stored in the friends directory exceeds the number of allowable entries, the entry with the lowest counter can be erased. Alternatively, the time and date of the last conversation can be stored, and the entry whose last conversation has the earliest time and date can be erased.

The steps carried out by both parties in placing an IT call using two ISBs are shown in the flow chart of Fig. 5. The calling party calls the called party via the PSTN in step 502, and the called party answers in step 504. In step 506, the parties agree to switch to an IT call, and in steps 508 and 510, each party's ISB disconnects (hangs up on the PSTN connection) and connects to that party's ISP. In steps 512 and 514, each party's ISB sends the calling and called telephone numbers and that ISB's IP address to the ISBSS. In step 516, each party gets the other party's IP address from the ISBSS, and in step 518, the parties talk via IT. The call is ended in step 520, and the parties hang up in steps 522 and 524.

During the call shown in Fig. 5, each party's ISB operates as shown in Fig. 6. In step 602, the ISB acts as a passive conduit for passing the call from the telephone to the PSTN. In step 604, the user presses the button to switch to an IT call. In step 606, the ISB hangs up on the PSTN call, and in step 608, the ISB calls the user's ISP and logs on. In step 610, the ISB contacts the ISBSS and sends the calling and called telephone numbers and that ISB's IP address. In step 612, the ISBSS sends the ISB the IP address of the other party's ISB, and the ISBs open an IT connection in step 614. In step 616, the user hangs up the telephone, and in step 618, the ISB logs off the ISP and hangs up from the telephone connection to the ISP.

A technique called "double packets" can be implemented to improve voice quality. In this technique, every packet is sent twice. Thus, if packets are dropped or sent out of sequence, voice quality will most likely not suffer. Packet dropping and out-of-sequence packet transmission are usually not a problem when the users' ISPs communicate over a common backbone or over backbones which have a peering arrangement (i.e., freely transmit packets over each other's facilities). However, if the two ISPs communicate over an NAP (network access point), packet dropping and transmission out of sequence are problems, which double packet transmission corrects.

There is a special kind of call known as a self-test call. When the user dials #5, the ISB initiates a call to a call completions server via the user's ISP. If the call is completed correctly, the user hears a recording from the call completions server to that effect. Otherwise, the user knows that there may be a problem with the ISB.

To implement the functionality noted above, the ISB can perform any of several calling operations: passive operation, establishing a connection to the ISP, PTIC (PSTN-to-Internet calling), MMIC (meet-me Internet calling), checking messages, sending messages, etc. These calling operations will now be explained with reference to Figs. 7A-7E and 8.

Passive operation will be explained with reference to Fig. 7A, which shows ISB 100 connected between telephone 211 and telephone line 212. In this operation, the ISB monitors the off-hook status of the telephone and the dialed digits via the connection to the telephone. Via the connection to the telephone line, the ISB monitors ring signals (incoming calls). If the first dialed digit is the pound sign ("#"), the ISB allows the user to control it via the menu system. Because IT is invoked through the menu system (and more specifically by dialing "#1"), IT is not invoked unless the first dialed digit is a pound sign. If more than six digits are called, the ISB operates as a PTIC caller, to be explained below, while if a ring signal is received from the telephone line, the ISB operates as a PTIC called party, to be explained below. Once the telephone is placed on-hook, all operations of the ISB are reset except the mode and the digit buffer.

Connection to the ISP will now be explained with reference to Fig. 7B. The modem is initialized, and telephone line 212 is monitored for a dial tone. ISB 100 dials the ISP access number to connect via PSTN 702 to modem rack 704 of the ISP. The modem of the ISB and a modem reached in modem rack 704 negotiate the baud rate and the protocol, whereupon ISB 100 is connected to the facilities of ISP 706. The ISB and the ISP perform any authentication procedure required, and the ISB selects "PPP" from the ISP's logon menu, if any. The ISB and the ISP then start communication by PPP, and PAP (the password authentication protocol) is carried out if no authentication has been performed before. The ISB is then connected by TCP to the ISP and thus via line 708, such as a T1 or T3 line or the like, to Internet backbone 710. If the call to the ISP results in a busy signal, the user can simply wait and call again. Alternatively, the ISB can be configured to store and dial multiple access numbers for one or more ISPs.

In case a user's ISP requires a special logon procedure, the ISB can have a scripting facility. This facility allows the ISB to store a logon script and to play the script to satisfy the ISP's logon requirements. The scripting language can be the same as that used for dial-up networking in Microsoft Windows 95, which is known in the art and will therefore not be explained here.

The script can be supplied to the ISB in different ways. For example, the user can compose the script on a PC and transfer the script to the ISB over a serial connection, or the agent at the help desk (to be explained in detail below) can remotely program the script into the

ISB. Alternatively, the ISB can store a boilerplate script with various components which can be enabled or disabled remotely by the agent. Still another way of programming the script into the ISB is to log on manually, while the ISB is connected to a PC over a serial connection, and to issue a command to automate the logon, as certain terminal emulation programs do. In any event, it should be possible to allocate 1,024 bytes in memory to store any script.

The operation of making a PTIC call will now be explained with reference to the diagram of Fig. 7C and the flow chart of Fig. 8. In Fig. 8, operational steps or states occurring at the same time are indicated by the same reference numeral, except suffixed by A (caller A's state), B (caller B's state) or C (user actions or common states).

Caller A uses telephone 211A, ISB 100A and ISP 706A, while caller B uses telephone 211B, ISB 100B and ISP 706B. Once the PTIC call is completed, they communicate over Internet 712, generally after communication over the Internet with ISBSS 714.

At the time at which user A dials user B in step 802C, user A's ISB is passive and off hook (step 802A), while user B's ISB is passive (step 802B). As user A dials, his ISB records the digits dialed in the digit buffer in step 804A and enters "PTIC caller" mode in step 806A. Then, in step 808A, user A's ISB becomes "passive," i.e., acts as a passive pass-through between user A's telephone set and the PSTN. In step 808C, user B's telephone rings, and in step 808B, user B's ISB goes into the "PTIC called" mode. User A talks to user B in step 810C, and once they agree to an IT call, they both hang up in step 812C. During these operations, their ISBs are "passive" (steps 810A, 810B, 812A, 812B). They both pick up their telephones and dial # in step 814C, whereupon their ISBs go into menu mode in steps 814A and 814B. They both dial 1 in step 816C to initiate ISP connections in steps 816A and 816B. While they both monitor (listen for the ring-back tone) in step 818C, their ISBs remain connected to their ISPs in steps 818A and

818B. The ISBs connect to the ISBSS in steps 820A and 820B, and the users hear ring-back tones in step 820C. The ISB data are exchanged in steps 822A and 822B, and the users hear a confirmation tone in step 822C. While the users continue their conversation in step 824C, the ISBs undergo dynamic adjustment in steps 824A and 824B. If either user's ISP drops that user's connection, that user can simply dial #1 again to be reconnected to the ISP and thus to the other user.

Dynamic adjustment will now be described with reference to Fig. 8A. Dynamic adjustment starts in step 8A02. In step 8A04, the first hundred packets (about one-third of a second) are monitored to determine transmission quality. More specifically, the baud rate and the percentage of dropped packets are measured. In response to these measurements, it is determined in step 8A06 whether one or more of the following need to be adjusted to maximize transmission within the bandwidth provided by the baud rate: the degree of compression (e.g., 6.3, 5.3, 4.8 or 4.1 kB/sec), the packetization (number of frames per packet, from one through five, which is also a measure of delay) and whether double packet transmission is turned on or off. For example, if the baud rate is 14.4 kilobaud and the percentage of dropped packets is below 10%, the ISBs may be adjusted to 6.3 kB/sec, two frames per packet and no double packets. At the same baud rate and a percentage of dropped packets of 10% or more, the ISBs may be adjusted to 4.1 kB/sec, five frames per packet and double packets. If the connection rate is greater than 16 kB and the rate of lost packets is 10% or less, the ISBs are adjusted to 6.3 kB/sec compression, one frame and no double packets; at the same connection rate and a higher rate of lost packets, the number of frames is increased, and double packets are used. The ISBs may implement this dynamic adjustment through a look-up table in the software; i.e., every combination of the baud rate and the percentage of dropped packets will correspond to a previously calculated and stored set of settings. For example, the look-up table is consulted in step 8A08, and the adjustment is made in step 8A10. Alternatively, calculation of the settings may be done on the fly. Once the adjustment is made, or if no adjustment is required, the dynamic adjustment ends in step 8A12. The ISB can be configured to abort the connection or any operation if the baud rate is less than 14.4 kB.

The hardware shown in Fig. 2 or 2B can be used to implement the dynamic adjustment of Fig. 8A. For example, the modem can detect the baud rate in a known manner, while the look-up table can be stored in whatever memory is provided (RAM, EEPROM, etc.), and the microprocessor can perform the remaining operations.

The ISB can be configured to give the following error messages, which can be used by either a user or a technical support person to determine why a call has not been completed normally:

| Error code | Problem |
|---|---|
| 0 | No dial tone |
| 1 | ISP busy |
| 2 | ISP did not answer |
| 3 | Logon failed, no logon prompt |
| 4 | Logon failed, no password prompt |
| 5 | Insufficient baud rate |
| 6 | PPP authentication failed |
| 7 | PPP failed |
| 8 | PPP timed out |
| 9 | Server did not connect |
| 10 | Server did not respond |
| 11 | Server rejected transaction |

| | |
|---|---|
| 12 | Reception terminated |
| 13 | Transmission terminated |
| 14 | Number not programmed |
| Error codes 20-24 refer to sending a voice mail message, to be described below. | |
| 20 | DNS did not answer |
| 21 | SMTP address wrong |
| 22 | SMTP user ID wrong |
| 23 | SMTP rejected message |
| 24 | SMTP disconnected |
| Error codes 30-34 refer to receiving a voice mail message, to be described below. | |
| 30 | DNS does not answer |
| 31 | POP address wrong |
| 32 | POP user ID/password wrong |
| 33 | POP stopped sending |
| 34 | POP disconnected |
| Error codes 40-42 refer to user programming of the ISB through the telephone keypad. | |
| 40 | Character not defined. |
| 41 | Character entered is not permissible where entered. |
| 42 | Too many characters. |

The error codes can be given to the user in the form of voice prompts. For example, if there is no dial tone, the ISB can play a first sound clip of a voice saying, "I'm sorry, but there is a problem with your Internet access; please try again. Error code ..." and a second sound clip of a voice saying, "zero." The user can consult the manual to find the significance of error code 0. In the case of errors which require a call to technical support, the user can make a note of the error code.

Variations on the PTIC call avoid incurring PSTN charges at all. Such variations include a previously agreed-upon signal that a particular person is calling, such as letting the telephone ring twice and then hanging up, and letting the telephone ring just long enough for caller ID information to be sent and then hanging up. The users then call each other back over the Internet as for a meet-me Internet call, which will now be described.

The MMIC, or meet-me Internet call, is a simplified version of the PTIC. In the MMIC, the users have previously agreed to call each other at a certain time, so no PSTN handshaking is required.

In the MMIC, both users dial #2 to access MMIC operation in their ISBs via the menu. User A enters user B's number, which user A's ISB verifies in its directory, and user A's ISB enters MMIC-caller mode. User B enters user A's number, which user B's ISB verifies in its directory, and user B's ISB enters MMIC-called-party mode. The rest of the conversation proceeds as for a PTIC call, i.e., steps 814A-C to 824A-C in Fig. 8.

Once two users have already called each other using the ISBs or otherwise added each other to their friends databases, MMIC can be used with a speed-dialing technique in which a user dials the last six digits of the other user's telephone number followed by #, regardless of where in the world the other user is, thereby avoiding long and confusing digit sequences for conventional international dialing. The ISB then matches the dialed last six digits with the friends data stored in the ISB to identify the other ISB which is to be called.

The last six digits can be used for a unique identification of up to a million other ISBs. While it is possible that a user's friends database will contain two entries having the same last six digits, this possibility is remote. Even if such a situation does arise, the ISB can be configured to prompt the user to dial more digits to identify the called party uniquely.

Checking and sending messages will now be explained with reference to Figs. 7D and 7E.

To check messages, the user dials #3 to enter message checking through the menu. The ISB connects to the ISP and then connects through ISP 706 and Internet 712 to POP server 716. Once this last connection is achieved, the ISB downloads and plays the first message. The user can then dial 1 to repeat, 2 to go to the next message or 3 to erase a message, much as he would with an answering machine. To send a message, the user dials #4, whereupon the ISB connects to the ISP and then connects through ISP 706 and Internet 712 to SMTP server 718 (the function of the SMTP server having been described above). The user can then record a message and then send it via the SMTP server to the recipient's e-mail address. The ISB can be configured to impose a time limit on outgoing messages (e.g., 60 seconds). The ISB can also be configured to poll the ISP periodically (e.g., four times a day or some other interval which is either set in the factory or programmed by the user) to check for message and to give an indication to the user via an LED or the like when messages are waiting.

The ISB can also be configured to poll the ISP periodically (e.g., four times a day or some other interval which is either set in the factory or programmed by the user), whenever a call is completed over IP, or both to check for message and to give an indication to the user via an LED or the like when messages are waiting. In one configuration, polling takes place only when all three of the following conditions are satisfied: (1) the polling period set in the ISB has expired, (2) the telephone has not been in use in the last two minutes and (3) no ring signal has been received in the last two minutes. Of course, the ISB can be equipped with an internal clock, such as those used in conventional IBM-compatible PCs, to allow periodic polling.

Each voice mail message is stored on the recipient's POP server in the form of an e-mail message with the sender's e-mail address listed in the "From:" field, a standard subject such as "ISB voice mail message" and a MIME attachment of the voice mail message in an appropriate sound file format. If the recipient checks his e-mail on the POP server with a conventional e-mail program such as Eudora, he will see such message interspersed among conventional e-mail messages. The ISB can distinguish the voice mail messages from the conventional e-mail messages by the subject.

The ISBSS will now be described in detail. The functionality described for the ISBSS can be implemented on a Sun Microsystems workstation running Solaris 2.6 or on any other sufficiently powerful computing device running an appropriate operating system. The server program executed by the ISBSS can be written in C++ or in any other suitable language. The primary purpose of the ISBSS, but not the exclusive function, is to provide connection information for two ISBs to engage in an IT call, since it is contemplated that the ISBs will not exchange information during the PSTN portion of the call. In addition, the ISBSS documents each completed call and each request for any other service, such as voice messaging and software upgrade requests, requested from ISBs and supported by the vendor of the ISBs.

The ISBSS is an iterative server. The server functions can be implemented in a single process and do not require threads. Each IT call involves two connections to the ISBSS, one from each of the ISBs. Each connection is kept open at most 200 msec after the three-way handshake is complete. The ISBSS software makes no blocking calls to any kernel function unless the ISBSS software is completely idle. In any connection to the ISBSS, there is one datagram sent in each direction.

The ISBSS provides service to the users of the ISBs by facilitating an exchange of IP addresses between two ISBs whose users want to communicate with each other. It does so by accepting a TCP connection request from each client, matching corresponding connection requests and sending the IP address of one of the ISBs to the other ISB. Otherwise, the ISBs might have to communicate their IP addresses to each other during the PSTN phase of the call. Such a procedure would require the modems of the ISBs to be set twice, once for the PSTN phase of the call and once for the IT phase of the call, and would render the MMIC call impossible. The use of the ISBSS allows the ISBs to set their modems only once, for the IT phase of the call, and makes the MMIC call possible.

The operation of the ISBSS will be described with reference to the flow chart of Fig. 9A. In steps 9A02 and 9A04, each ISB sends the ISBSS a connection request, which is a data string including the following: that party's serial number, the other party's serial number, that party's telephone number, the other party's telephone number, that party's IP address, version number and the like. For a PTIC, the calling party's telephone number is not required. The ISBSS searches for a match between the ISB and a waiting list of ISB's. If there is no match, as in step 9A06 (where caller A's request has been received first), the ISB is appended to the waiting list or queue in step 9A08 and is instructed by the ISBSS to expect a call from another ISB. If there is a match, as in step 9A10 (where caller B's request has been received second), the ISB matches the requests in step 9A12 to find the IP address of the other party's ISB in step 9A14. In step 9A16, the ISBSS forwards caller A's IP address to caller B's ISB, and in step 9A18, caller B's ISB attempts to contact caller A's ISB using the thus obtained IP address, whereupon the ISBSS has no more involvement in the call. Thus, when two parties want to call each other, the first received connection request is queued, and the second received connection request is answered with the IP address of the first received request.

By holding connection requests in a data structure in this manner, the ISBSS can avoid holding open a TCP connection to any particular ISB for more than a few microseconds, thus reducing load on the ISBSS. In fact, the ISBSS can break the TCP connection immediately upon receiving the connection request.

The ISBSS can also send commands to an ISB while processing a connection request. Such instructions can, for example, instruct the ISB to modify the friends data or other data stored locally in the ISB.

As the number of ISBs in use increases, more ISBSSs can be added. Multiple ISBSSs can coordinate their services; for example, an ISBSS can send an instruction to an ISB if the connection request should be made to another ISBSS.

The ISBSS stores telephone numbers in BCD (binary coded decimal) notation with the least significant digit of the telephone number stored in the most significant nibble (four bits) of the first byte (8 bits) of the telephone number string. With this approach, the ISBSS can allow the possibility of six-digit dialing to any ISB in the world. The code to implement this feature is shown in Figs. 10A and 10B.

A state diagram of the ISBSS is shown in Fig. 11. The basic design of the ISBSS software is that of a finite state machine. The states in the machine are prioritized such that if conditions allow the ISBSS to enter more than one state simultaneously, the higher priority state is entered first. After completing work to be done in any given state, the machine always returns to the "idle" state. The states are listed below, with a priority number of each state; a higher number indicates a higher priority.

Idle (0): The default state, in which the ISBSS does housekeeping on its internal data structures while waiting for requests for service which would send it into some other state.

ISB Connection Request (4): The ISBSS enters this state after completion of a three-way handshake. The ISBSS accepts all pending connection requests at this time.

ISB Connection Read (5): The ISBSS enters this state when a particular connection has data ready to be read by the ISBSS. The data are read, verified and processed. The need to write the given connection is announced.

ISB Connection Write (6): The ISBSS enters this state only when a particular connection is ready to write the single datagram which the ISBSS writes to each connection. The write takes place, and the disconnect timer is set to expire in a predetermined time, such as 200 msec.

ISB Connection Disconnect (7): The ISBSS enters this state only when the disconnect timer expires for a particular connection. The ISBSS aborts the connection and frees up any space used to maintain the connection.

Telnet Connection Request (1): In addition to serving ISB requests, the ISBSS has a Telnet-like interface for issuing commands to the ISBSS. The ISBSS enters this state only when the listening service indicates that a request for connection has been completed. Only one such Telnet connection is permissible at a time. Each new request results in a dropping of the previous request. The commands include -A to set a parameter (such as the connection list time out in seconds and the billing file size in records, with the syntax being -A parametername newvalue), -B to dump the billing file, -C list to list the commands currently available, -C set (actual command) to send that command to all connection requests, -H for help, -L for a parameter list, -M $n$ to monitor for $n$ minutes if $n > 0$ or to turn off monitoring if $n = 0$, -Q (password) to quit, -T on or -T off to turn testing on or off, and -V (serial number) (status) to add the given serial number to the list of invalid serial number if (status) > 0 or to remove the given serial number from the list of invalid serial numbers if (status) = 0.

Telnet Connection Read (2): The ISBSS enters this state only if a command has been received on the Telnet connection and is ready to be read.

Telnet Connection Write (3): Everything which needs to be sent to the Telnet connection is buffered asynchronously in a message list. The ISBSS enters this state and sends a single message if the message list is not empty.

In a connection with an ISB, the ISBSS receives a connection data structure and sends a response data structure. The connection data structure is shown in Fig. 11A, wherein the tx_data array has a structure shown in Fig. 11B and the tx_BillingData structure is shown in Fig. 11C. The response data structure is sent to every connecting ISB unless the incoming datagram is incorrect and has a structure shown in Fig. 11D, wherein the tx_data array has a structure shown in Fig. 11E.

The ISBSS is able to monitor its own behavior over a specified range of any number of minutes. The number of minutes is specified by a Telnet command described above. The output of the monitoring process is shown in an illustrative example in Fig. 11F. The data shown in Fig. 11F show the number of connection requests and the manner in which they were processed.

The ISBSS is also able to maintain a log of any errors or suspect situations which arise in running the server program. A sample log file is shown in Fig. 11G.

While it is contemplated that the ISBSS will be a public server accessible to all ISB users, it is also possible that an ISBSS will be supplied, either as a workstation with the software installed or as software for installation on a separately supplied workstation, to an organization which wishes to maintain its own dedicated ISBSS to supply connection information to ISBs within that organization. The ISBs can be programmed to use this dedicated ISBSS for calls within the organization or a public ISBSS for other calls, which are called off-net calls and initiated by dialing #8. Off-net calls can also be made by users of the public ISBSS to call one another via a backup ISBSS when their usual ISBSS is down and automatic reroute routines fail.

MMIC calls are treated similarly to PTIC calls. In MMIC calls, it does not matter which

ISB is the calling ISB and which is the called ISB, so that the ISBSS can assign these roles arbitrarily. In an MMIC call, the users may not coordinate the time of their call properly, in which case the calling party's request remains in the queue in the ISBSS. Either the ISB or the ISBSS can be configured to wait a certain period of time and request via a voice prompt that the user try the call again later.

In sending voice mail, the ISBSS has no involvement beyond sending a "Go ahead and send your voice mail" message, whereupon the ISBSS disconnects. In the Internet test call, the ISBSS disconnects after sending a "test complete" message.

The ISBSS can be used to program the ISB automatically as needed. The ISBSS uses the same commands which would be used to program the ISB from a PC over a serial connection. The ISBSS programs server information, e.g., the ISBSS's IP address and the feature key.

Another use of the ISBSS is to notify a customer that an upgrade is available. Whenever the ISB contacts the ISBSS, the ISBSS can supply the current software version number, which is compared with the version number of the software in the ISB. If the current version number is higher, an LED lights up on the ISB to inform the customer of the availability of the upgrade. The ISBSS supplies the ISB with the IP address of the upgrade server from which the upgrade is available and then disconnects.

In the programming and upgrade notification operations just described, the ISBSS can send the following commands to the ISB:

"Turn on the 'upgrade available' LED."

"Use the accompanying IP address as the new address for the main ISBSS."

"Use the accompanying IP address as the new address for the backup ISBSS."

The ISBSS can also reject a connection request, for example, if a caller's bill is sufficiently overdue, if the serial number or telephone number in the connection request is invalid, or if the ISBSS lacks memory or process time. When an ISB's attempt to contact the ISBSS fails three times, the ISB assumes that the ISBSS is not functional and tries to connect to a secondary ISBSS.

Each connection to the ISBSS is accompanied by data describing the service most recently completed by the connecting ISB (usually about the most recently connected telephone call before the current call request). Such data are written to a log file for future processing.

Other servers besides the ISBSS can be used. For example, a backup ISBSS can be added and can become active when the main ISBSS fails or passes control. Also, auxiliary servers such as an upgrade server, an inquiry server, an H.323 server, a commercial server and the like can be used.

A particular server which can be used with the ISB system is called a billing server. The billing server maintains information regarding each completed IT call for billing purposes. The ISBSS can supply this information to the billing server. The billing record for each call includes the caller telephone number, the caller serial number, the called telephone number, the called serial number, the start time and date, the call duration and the quality of the connection. To determine the quality of the connection, the billing server or another server can maintain a statistical record, either globally or for each call. The statistical record can include such information as the percentage of lost packets, the percentage of late packets, the percentage of packets out of sequence, the percentage of discarded transmission packets, the percentage of discarded reception packets, and, for each of the parties to the call, the baud rate, the compression rate, and the frames.

The billing information is collected for all different transactions of an ISB. To make this process more efficient, the billing information about a transaction is passed to the billing sever at the beginning of the next transaction.

The ISB generates a billing record as follows. When the ISB contacts the ISBSS for a transaction, the ISB receives the current time from the ISBSS and produces a partial billing record which includes the start time and the telephone number of the other party (the latter field being left blank when it is inapplicable, e.g., when checking messages). At the end of the transaction, the ISB adds the duration to the partial billing record to produce a complete billing record, which is provided to the billing server at the beginning of the next transaction.

A feature which a company selling ISBs can provide to enhance the functionality of the ISBs is called the "help desk." Through the help desk, customer service agents can assist customers by remotely programming their ISBs, answering questions about the service, upgrade the software in the ISBs, etc.

Fig. 9 shows a connection between a customer's location 900C and an agent's position 900HD at the help desk. The help desk has one or more call center positions 900HD, each equipped with a standard telephone 211HD, a computer or data terminal 908 and a specially equipped ISB 100HD connected to computer or data terminal 908 via a serial port or other connection such as serial port 408 of Fig. 4. The customer connects to the help desk via PSTN 902, customer's ISP 904C, Internet 906 and help desk's ISP 904HD. The agent can use ISB 100HD to access, program, upgrade and test customer's ISB 100C. The agent can change the data stored in ISB 100C (for example, the device data, server data and owner data). The help desk does not have to change the data maintained automatically by ISB 100C or by other servers (e.g., friends data, billing data and service records). Also, the agent and the customer can talk via telephones 211C and 211HD, either in voice over data via the Internet or in voice-only mode via the Internet or the PSTN, so that the agent can answer the customer's questions. The user can initiate a voice-over-data conversation by dialing *0#.

Programming of the ISB from the help desk takes place in the following manner. The customer and the agent engage in a conversation, either by IT or by the PSTN. If the agent decides that the customer's ISB 100C is to be remotely programmed from the help desk, the agent instructs the customer to dial *0# into telephone 211C. The agent verifies that the customer's ISB 100C has accepted this code to go into voice-over-data mode and enters a similar command to set his own ISB 100HD to voice-over-data mode. The ISBs 100C and 100HD perform a modem handshaking and then start a PPP link between them. Once the link is established, the bandwidth is shared between voice and data, and the agent and the customer can resume their conversation while the agent accesses, examines and programs the customer's ISB 100C.

The agent's computer or data terminal 908 has software to allow the agent to access, examine and program the customer's ISB 100C in this manner. The software displays a window into which the agent enters his own identifying information, device data such as the serial number, feature key and hardware and software versions, server IP addresses, and the user data. The window also has buttons to allow the agent to read the data stored in the customer's ISB, write data to the customer's ISB, activate voice-over-data mode, save information about the customer's ISB to disk for future reference, and load that information from disk. The window offers menu options to allow the agent to log on and off his position at the help desk, to change the serial port settings for his position at the help desk, to select the source for data being accessed as local (the help desk position) or remote (the customer's ISB) and the like.

As those skilled in the art will readily appreciate, the various components described above form a coherent system which is shown in Fig. 12. In this system, multiple customer locations 900C and help desk location 900HD, which have already been described, interface via PSTN 902 and ISPs 904C, 904HD with one another and with ISPs 904S, which allow access to one or more ISBSSs 1201, one or more e-mail (POP, SMTP, IMAP (which is another mail protocol), etc.) servers 1204, one or more billing servers 1206, one or more Web servers 1208 and any other servers or other system components which can be used.

The present invention can be adapted for use with the H.323 communication standard, which will now be described briefly with reference to Fig. 13. The H.323 standard provides interoperability among products from multiple vendors. The standard includes the H.320 standard for ISDN (integrated services digital network) communication and H.324 for the PSTN. The standard provides for encapsulation of UDP packets (which have been identified above) as RTP (real-time transport protocol) packets.

Fig. 13 shows various components of an H.323 system. Those skilled in the art will readily appreciate that not all components shown in Fig. 13 will necessarily be present.

H.323 system 1300 is implemented on LAN (local-area network) 1302. Terminals 1304 are used by users to communicate; each terminal 1304 can include an ISB, with or without video capabilities, or an PC with audio or audio-video capabilities. Gateway 1306 provides interoperability with other networks, e.g., over PSTN 1308 or ISDN line 1310. MCU (multipoint control unit) 1312 control conferencing among three or more terminals. Gatekeeper 1314 performs network functions such as bandwidth control and translation between IP addresses and names by which terminals 1304, gateway 1306, etc. are known to LAN 1302.

The ISB software is written such that at any time during the operation the user can terminate whichever operation is in progress by simply hanging up the telephone and can hear a dial tone by picking up the telephone again. There might be instances in which the hang-up is not recognized by the software because of unexpected interactions between the software and real-life conditions. To prevent the ISB from locking up and possibly blocking the telephone from the user, a watchdog timer can be implemented to recover from these situations and reset the system. In all other instances in which the ISB recognizes that an error has occurred, it plays a prompt which in general terms explains the condition followed by an error code which helps the user to troubleshoot the problem by referring to the manual or which helps the agent at the help desk to diagnose the problem. The error codes have been listed above, although, of course, other error codes could be assigned as needed.

In the instances in which the ISB expects the user to enter data or hang up, a timer can be set with a predefined time-out value. If the user does not respond within time-out period, the prompt is repeated. This process can be repeated up to three times, and if there is no response from the user, then the ISB goes on-hook and, after a short delay, back off-hook .

The ISB can be tested at the factory or elsewhere in the following manner. The ISB is connected to a telephone and to a computer in the manner described above. The computer has appropriate testing software installed thereon. The tester makes a call through the ISB to a second ISB which has been tested and is known to work properly. Any aspect of operation of the ISB under test can be tested, and a report can be generated.

The foregoing detailed description covers interfacing a wireline analog version of the ISB and is illustrative of the various preferred embodiments of the present invention which also include wireline digital versions which are ISDN or LAN based as well as wireless analog or digital versions, either cellular or PCS (personal communication systems). The ISB can also be adapted to work with facsimile machines. The invention is not limited to embodiments using a

SLIP, PPP or other dialup connection to the Internet; instead, any connection to the Internet or another secondary network, such as a T1 line or a cable modem, can be used. Also, while it is contemplated that a caller will usually want to speak to one called party at a time, conference calls can be implemented with no difficulty. In addition, ISBs can be made with inexpensive digital cameras and LCD screens to allow videophone service by using Internet audiovisual conferencing software such as CU-Seeme. ISBs can also be provided with encryption. Moreover, modifications disclosed separately can be combined in any technically feasible manner, while modifications disclosed together can be implemented separately wherever technically feasible. It will be appreciated that numerous variations and changes can be made not only to provide a range of services but also to interface the many different devices used to access the PSTN, including personal computers and laptops, without departing from the scope of the invention as defined in the accompanying claims.

We claim:

1. A switch box for connecting a first telephone set and a second telephone set over a selected one of a primary network and a secondary network, the switch box comprising:

primary network connecting means for connecting the first telephone set to the primary network;

secondary network connecting means for connecting the first telephone set to the secondary network, for receiving address information from the secondary network to locate the second telephone set on the secondary network and for establishing a connection over the secondary network between the first telephone set and the second telephone set;

relay means for (i) connecting, when the relay means is in a first state, the first telephone set to the primary network connecting means and for (ii) connecting, when the relay means is in a second state, the first telephone set to the secondary network connecting means; and

switching means for receiving a switch-over command to switch from the primary network to the secondary network and for controlling, in response to the switch-over command, (i) the relay means to disconnect the first telephone set from the primary network connecting means and to connect the first telephone set to the secondary network connecting means and (ii) the secondary network connecting means to establish the connection over the secondary network between the first telephone set and the second telephone set.

2. A switch box as in claim 1, wherein the switching means comprises:

a button on the switch box; and

means for receiving the switch-over command through actuation of the button.

3. A switch box as in claim 1, wherein the switching means comprises means for monitoring the first telephone set to receive the switch-over command through the first telephone

set.

4. A switch box as in claim 1, wherein the primary network connecting means comprises means for providing a passive pass-through connection between the first telephone set and the primary network.

5. A switch box as in claim 4, wherein:

the primary network is an analog circuit-switched telephone network;

the secondary network is a digital packet-switched data network; and

the secondary network connecting means comprises means for (i) connecting the first telephone set to the digital packet-switched data network, (ii) connecting the first telephone set to the second telephone set over the digital packet-switched data network and (iii) exchanging packets representing voice signals between the first telephone set and the second telephone set over the digital packet-switched data network.

6. A switch box as in claim 4, wherein the secondary network connecting means comprises:

a microprocessor for controlling the connection over the secondary network between the first telephone set and the second telephone set;

memory means for storing embedded software for execution by the microprocessor;

modem means for permitting communication between the microprocessor and the secondary network; and

signal processing means for converting between the voice signals and the packets.

7. A switch box as in claim 6, wherein the signal processing means comprises a vocoder.

8. A switch box as in claim 6, wherein the signal processing means comprises a digital signal processor.

9. A switch box as in claim 6, wherein the embedded software comprises software for the microprocessor to store identifying information in the memory means regarding the second telephone set, the identifying information being used to retrieve the address information.

10. A switch box as in claim 9, wherein the identifying information regarding the second telephone set comprises a telephone number identifying the second telephone set.

11. A system for communication over a selected one of a primary network and a secondary network, the system comprising a plurality of switch boxes, each for connection to a telephone set, each of the plurality of switch boxes comprising:

primary network connecting means for connecting the telephone set to the primary network;

secondary network connecting means for connecting the telephone set to the secondary network, for receiving address information from the secondary network to locate another telephone set connected to another switch box from among the plurality of switch boxes and for establishing a connection over the secondary network between the telephone set and said other telephone set;

relay means for (i) connecting, when the relay means is in a first state, the telephone set to the primary network connecting means and for (ii) connecting, when the relay means is in a second state, the telephone set to the secondary network connecting means; and

switching means for receiving a switch-over command to switch from the primary network to the secondary network and for controlling, in response to the switch-over command, (i) the relay means to disconnect the telephone set from the primary network connecting means and to connect the telephone set to the secondary network connecting means and (ii) the secondary network connecting means to establish the connection over the secondary network between the telephone set and the other telephone set.

12. A system as in claim 11, wherein the switching means comprises:

a button on the switch box; and

means for receiving the switch-over command through actuation of the button.

13. A system as in claim 11, wherein the switching means comprises means for monitoring the telephone set to receive the switch-over command through the telephone set.

14. A system as in claim 11, wherein the primary network connecting means comprises means for providing a passive pass-through connection between the telephone set and the primary network.

15. A system as in claim 14, wherein:

the primary network is an analog circuit-switched telephone network;

the secondary network is a digital packet-switched data network; and

the secondary network connecting means comprises means for (i) connecting the telephone set to the digital packet-switched data network, (ii) connecting the telephone set to the other telephone set over the digital packet-switched data network and (iii) exchanging packets representing voice signals between the telephone set and the other telephone set over the digital packet-switched data network.

16. A system as in claim 14, wherein the secondary network connecting means comprises:

a microprocessor for controlling the connection over the secondary network between the telephone set and the other telephone set;

memory means for storing embedded software for execution by the microprocessor;

modem means for permitting communication between the microprocessor and the secondary network; and

signal processing means for converting between the voice signals and the packets.

17. A system as in claim 16, wherein the signal processing means comprises a vocoder.

18. A system as in claim 16, wherein the signal processing means comprises a digital signal processor.

19. A system as in claim 16, wherein the embedded software comprises software for the microprocessor to store identifying information in the memory means regarding the other telephone set, the identifying information being used to retrieve the address information.

20. A system as in claim 19, wherein the identifying information regarding the other telephone set comprises a telephone number identifying the other telephone set.

21. A system as in claim 14, further comprising server means, in communication with the digital packet-switched data network, for (i) receiving a connection request from a first one of the switch boxes which wants to establish a connection over the digital packet-switched data network to a second one of the switch boxes and (ii) sending to the first one of the switch boxes the address information regarding the second one of the switch boxes to allow the first one of the switch boxes to connect to the second one of the switch boxes.

22. A system as in claim 21, wherein the address information regarding the second one of the switch boxes comprises an IP address of the second one of the switch boxes.

23. A system as in claim 21, wherein the server means comprises means for (i) receiving connection requests from the first and second ones of the switch boxes, (ii) queuing a first received one of the connection requests in a queue and (iii) searching the queue in response to a second received one of the connection requests to match the connection requests.

24. A system as in claim 11, further comprising a help desk in communication with at

least one of the primary network and the secondary network, the help desk having at least one agent station, each of the at least one agent station comprising:

a telephone set, connected to said at least one of the primary network and the second network, for voice communication with the telephone set connected to any of the plurality of switch boxes; and

means for programming said any of the plurality of switch boxes over said at least one of the primary network and the secondary network.

25. A device for allowing a user with a telephone set to send and receive voice mail to and from an electronic mail server on a digital data network, the device comprising:

signal processing means, connected to the telephone set, for (i) converting an outgoing voice mail message spoken by the user into the telephone into an outgoing digital message and (ii) converting an incoming digital message into an incoming voice mail message and playing the incoming voice mail message over the telephone to the user;

communication means, connected to the signal processing means and the digital data network, for (i) sending the outgoing digital message to the electronic mail server for delivery to a recipient and (ii) retrieving the incoming digital message from the electronic mail server; and

control means, connected to the communication means, for receiving commands from the user and for controlling the communication means, in accordance with the commands, to supply the electronic mail server with information identifying the recipient so that the outgoing digital message is delivered to the recipient and to control retrieval and erasure of the incoming digital message from the electronic mail server.

26. A device as in claim 25, wherein the control means comprises means for monitoring the telephone set to receive the commands input by the user through the telephone set.

27. A device as in claim 25, wherein the information identifying the recipient comprises an electronic mail address for the recipient.

28. A device as in claim 25, wherein the control means is further connected to the signal processing means and comprises means for controlling playback of the incoming voice message in accordance with the commands.

29. A method for connecting a first telephone set and a second telephone set over a of a primary network and then a secondary network, the method comprising:

(a) establishing a first connection between the first telephone set and the second telephone set over the primary network;

(b) agreeing to switch to the second network and disconnecting both the first telephone set and the second telephone set from the primary network;

(c) connecting the first telephone set and the second telephone set to the secondary network;

(d) providing, over the secondary network, at least one of the first telephone set and the second telephone set with address information to connect the first telephone set with the telephone set over the secondary network; and

(e) connecting the first telephone set to the second telephone set via the secondary network.

30. A method as in claim 29, wherein step (b) comprises actuating a dedicated button on a device attached to each of the first telephone set and the second telephone set to disconnect the first telephone set and the second telephone set from the primary network.

31. A method as in claim 29, wherein step (b) comprises issuing a command through a keypad of each of the first telephone set and the second telephone set to disconnect the first

telephone set and the second telephone set form the primary network.

32. A method as in claim 29, wherein each of the first telephone set and the second telephone set is connected to the primary and secondary networks through a switch box which provides a passive pass-through connection to the primary network during step (a).

33. A method as in claim 32, wherein:

the primary network is an analog circuit-switched telephone network;

the secondary network is a digital packet-switched data network; and

step (e) comprises (i) connecting the first telephone set to the second telephone set over the digital packet-switched data network and (ii) exchanging packets representing voice signals between the first telephone set and the second telephone set over the digital packet-switched data network.

34. A method as in claim 33, wherein the switch box connected to the first telephone set comprises a memory for storing identifying information regarding the second telephone set, the identifying information being used to retrieve the address information.

35. A method as in claim 34, wherein the identifying information regarding the second telephone set comprises a telephone number identifying the second telephone set.

36. A method as in claim 33, wherein step (d) comprises:

(i) sending a connection request from a first one of the switch boxes to a server; and

(ii) sending from the server to the first one of the switch boxes the address information regarding the second one of the switch boxes to allow the switch boxes to connect.

37. A method as in claim 36, wherein the address information regarding the second one of the switch boxes comprises an IP address of the second one of the switch boxes.

38. A method as in claim 36, wherein:

both switch boxes send connection requests to the server; and

step (d)(ii) comprises:

(A) queuing a first received one of the connection requests in a queue; and

(B) searching the queue in response to a second received one of the connection requests to match the connection requests.

39. A method for allowing a user with a telephone set to send and receive voice mail to and from an electronic mail server on a digital data network, the method comprising:

(a) converting an outgoing voice mail message spoken by the user into the telephone into an outgoing digital message;

(b) converting an incoming digital message into an incoming voice mail message and playing the incoming voice mail message over the telephone to the user;

(c) sending the outgoing digital message to the electronic mail server for delivery to a recipient;

(d) retrieving the incoming digital message from the electronic mail server; and

(e) receiving commands from the user and, in accordance with the commands, supplying the electronic mail server with information identifying the recipient so that the outgoing digital message is delivered to the recipient and controlling retrieval and erasure of the incoming digital message from the electronic mail server.

40. A method as in claim 39, wherein step (e) comprises monitoring the telephone set to receive the commands input by the user through the telephone set.

41. A method as in claim 39, wherein the information identifying the recipient comprises an electronic mail address for the recipient.

42. A method as in claim 39, further comprising controlling playback of the incoming

voice message in accordance with the commands.

43. A device for dynamically adjusting a communication between a computing device and a digital packet-switched network, the device comprising:

detecting means for monitoring at least a portion of the communication and for detecting a baud rate and a percentage of dropped packets in said at least a portion of the communication;

determining means for making a determination, in accordance with the baud rate and the percentage of dropped packets, as to whether a degree of compression, a packetization and a packet redundancy in the communication are acceptable for the baud rate; and

adjusting means for adjusting at least one of the degree of compression, the packetization and the packet redundancy in accordance with the determination.

44. A device as in claim 43, wherein the determining means comprises:

means for storing a look-up table; and

means for making the determination by applying the baud rate and the percentage of dropped packets to the look-up table.

45. A device as in claim 43, wherein:

the packet redundancy is adjustable to a first state or a second state;

in the first state, each packet in the communication is sent twice; and

in the second state, each packet in the communication is sent once.

46. A method for dynamically adjusting a communication between a computing device and a digital packet-switched network, the method comprising:

(a) monitoring at least a portion of the communication and detecting a baud rate and a percentage of dropped packets in said at least a portion of the communication;

(b) making a determination, in accordance with the baud rate and the percentage of dropped packets, as to whether a degree of compression, a packetization and a packet redundancy in the communication are acceptable for the baud rate; and

(c) adjusting at least one of the degree of compression, the packetization and the packet redundancy in accordance with the determination.

47. A method as in claim 46, wherein step (b) comprises:

(i) storing a look-up table in a memory; and

(ii) making the determination by applying the baud rate and the percentage of dropped packets to the look-up table.

48. A method as in claim 46, wherein:

the packet redundancy is adjustable to a first state or a second state;

in the first state, each packet in the communication is sent twice; and

in the second state, each packet in the communication is sent once.

49. A server for allowing a first device and a second device to communicate over a packet-switched network, the server comprising:

means for receiving (i) a first communication request from the first device, the first communication request comprising first address information for locating the first device on the network, and (ii) a second communication request from the second device, the second communication request comprising second address information for locating the second device on the network; and

means for (i) maintaining a communication request queue, (ii) adding a first received one of the first and second communication requests to the queue, (iii) searching the queue in accordance with a second received one of the first and second communication requests to match the first and second received ones of the first and second communication requests (iv) if the second received one of the first and second communication requests is the first communication request, providing the second address information to the first device, and (v) if the second received one of the first and second communication requests is the second communication request, providing the first address information to the second device.

50. A server as in claim 49, wherein each of the first and second address information comprises an IP address.

51. A method for allowing a first device and a second device to communicate over a packet-switched network, the method comprising:

(a) receiving a first communication request from the first device, the first communication request comprising first address information for locating the first device on the network;

(b) receiving a second communication request from the second device, the second communication request comprising second address information for locating the second device on the network;

(c) maintaining a communication request queue;

(d) adding a first received one of the first and second communication requests to the queue;

(e) searching the queue in accordance with a second received one of the first and second communication requests to match the first and second received ones of the first and second communication requests;

(f) the second received one of the first and second communication requests is the first communication request, providing the second address information to the first device; and

(g) if the second received one of the first and second communication requests is the second communication request, providing the first address information to the second device.

52. A method as in claim 51, wherein each of the first and second address information comprises an IP address.

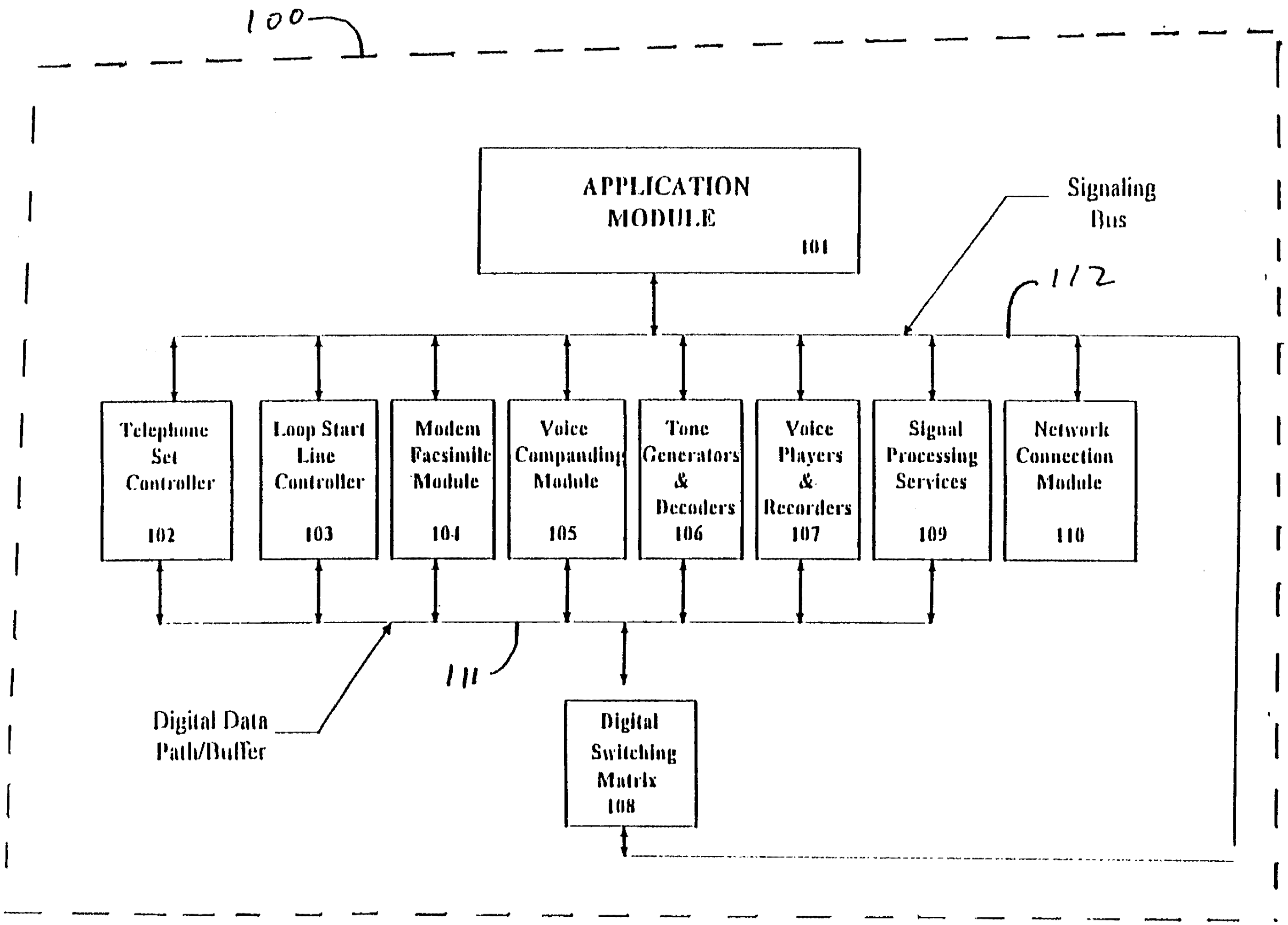

100
APPLICATION MODULE
101
Signaling Bus
112
Telephone Set Controller
102
Loop Start Line Controller
103
Modem Facsimile Module
104
Voice Companding Module
105
Tone Generators & Decoders
106
Voice Players & Recorders
107
Signal Processing Services
109
Network Connection Module
110
111
Digital Data Path/Buffer
Digital Switching Matrix
108

Fig. 1

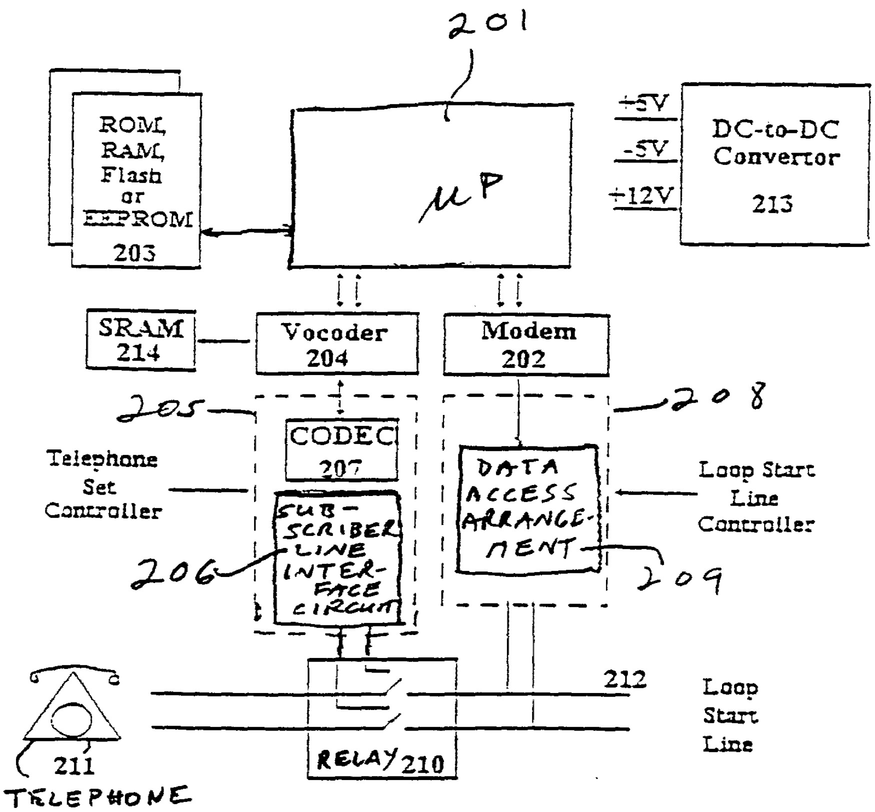

201
ROM, RAM, Flash or EEPROM
203
μP
+5V
-5V
+12V
DC-to-DC Convertor
213
SRAM
214
Vocoder
204
Modem
202
205
208
CODEC
207
Telephone Set Controller
SUB-SCRIBER LINE INTER-FACE CIRCUIT
206
DATA ACCESS ARRANGE-MENT
209
Loop Start Line Controller
212
Loop Start Line
211
TELEPHONE
RELAY 210

Figure 2

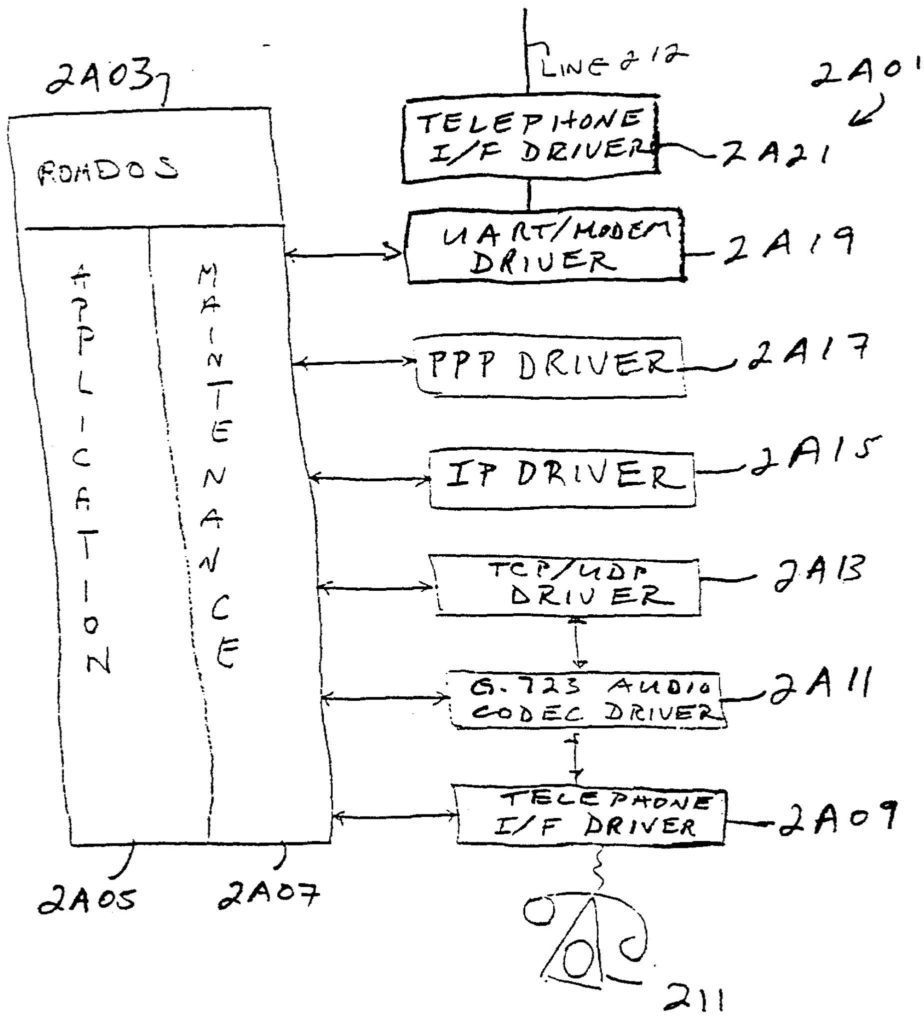

LINE 212
2A01
2A03
ROMDOS
APPLICATION
MAINTENANCE
TELEPHONE I/F DRIVER
2A21
UART/MODEM DRIVER
2A19
PPP DRIVER
2A17
IP DRIVER
2A15
TCP/UDP DRIVER
2A13
G.723 AUDIO CODEC DRIVER
2A11
TELEPHONE I/F DRIVER
2A09
2A05
2A07
211

Fig. 2A

Fig. 2B

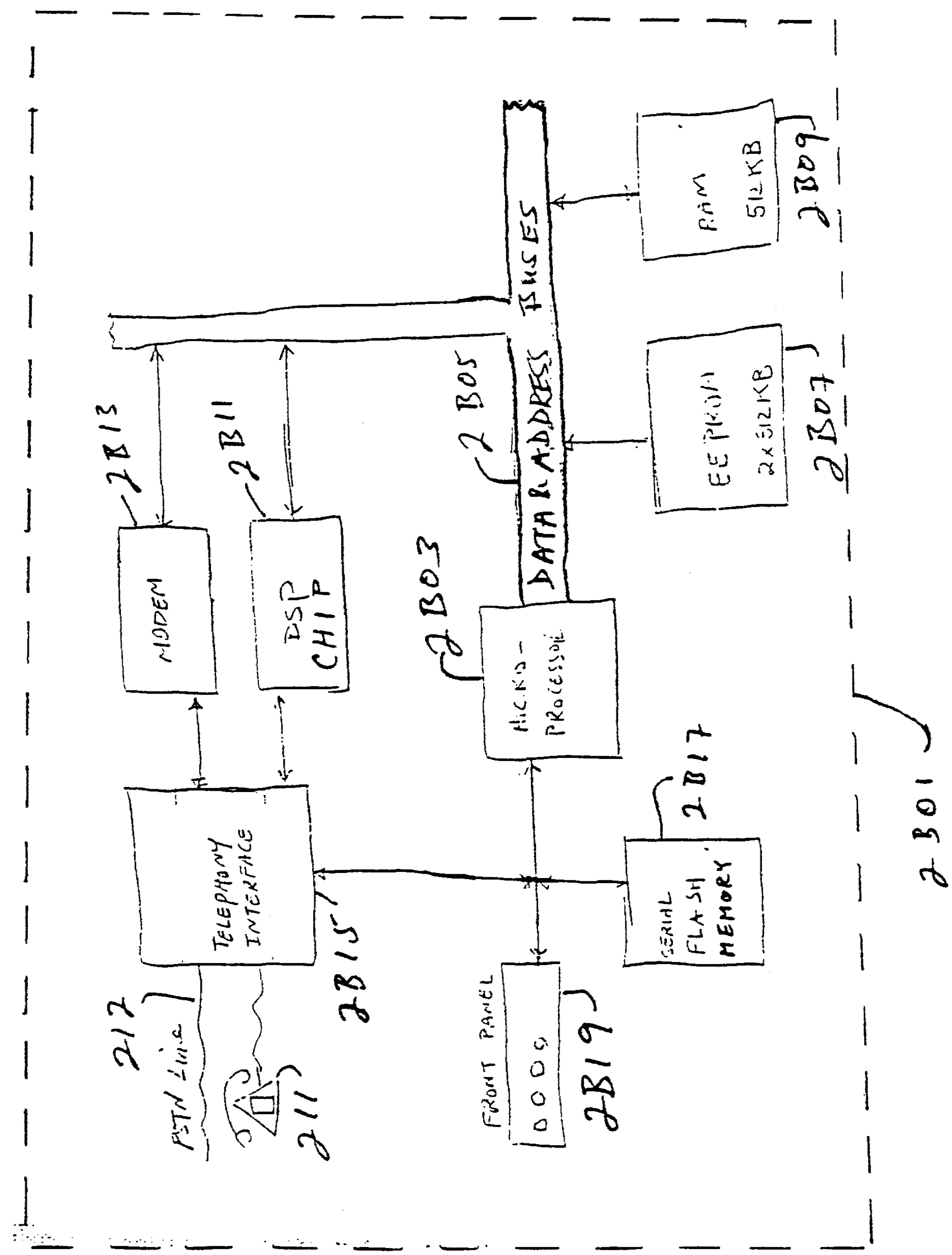

MODEM
DSP CHIP
MICRO-PROCESSOR
DATA ADDRESS BUSES
RAM 512KB
EEPROM 2x512KB
TELEPHONY INTERFACE
SERIAL FLASH MEMORY
FRONT PANEL
PSTN Line
2B01
2B03
2B05
2B07
2B09
2B11
2B13
2B15
2B17
2B19
211
212

Fig. 3

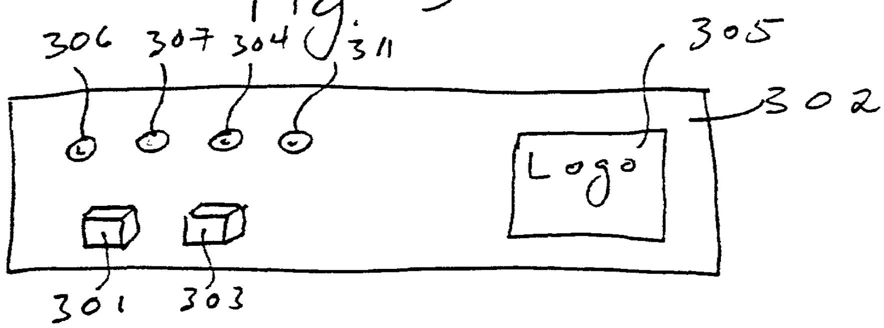



Fig. 4

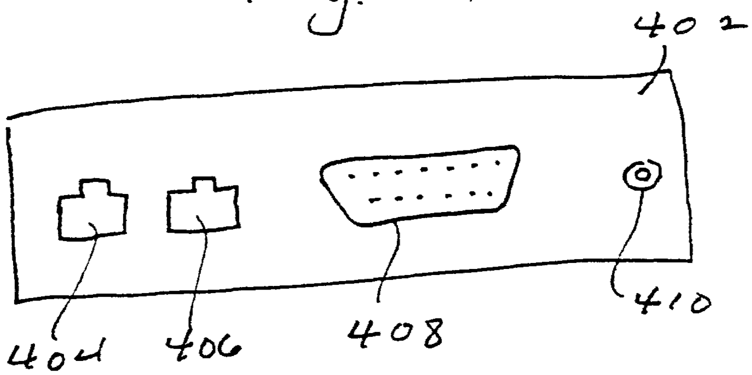


Fig. 5

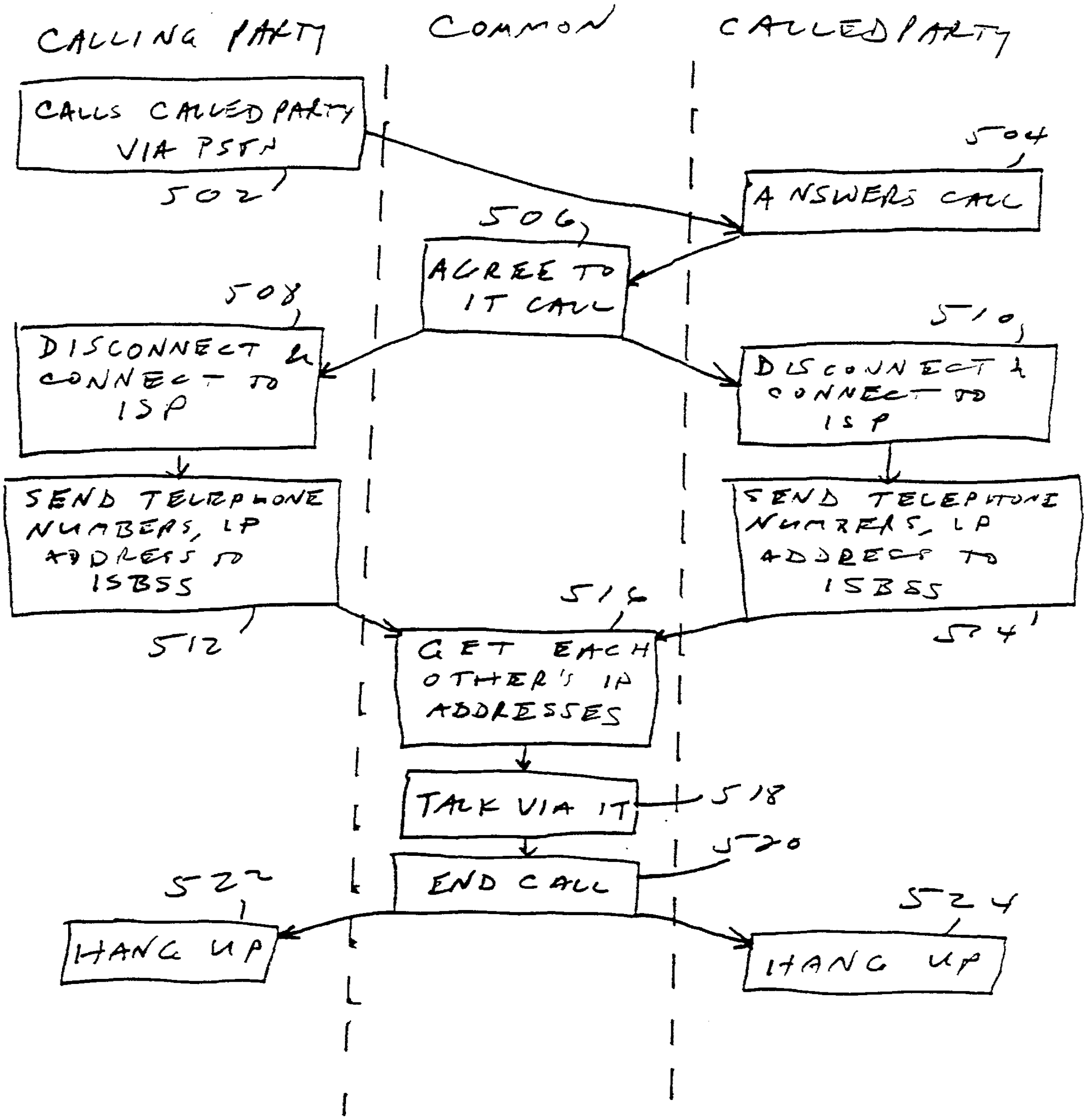

CALLING PARTY
COMMON
CALLED PARTY
CALLS CALLED PARTY VIA PSTN
502
504
ANSWERS CALL
506
AGREE TO IT CALL
508
DISCONNECT & CONNECT TO ISP
510
DISCONNECT & CONNECT TO ISP
SEND TELEPHONE NUMBERS, IP ADDRESS TO ISBSS
SEND TELEPHONE NUMBERS, IP ADDRESS TO ISBSS
512
516
514
GET EACH OTHER'S IP ADDRESSES
TALK VIA IT
518
520
END CALL
522
524
HANG UP
HANG UP

Fig. 6

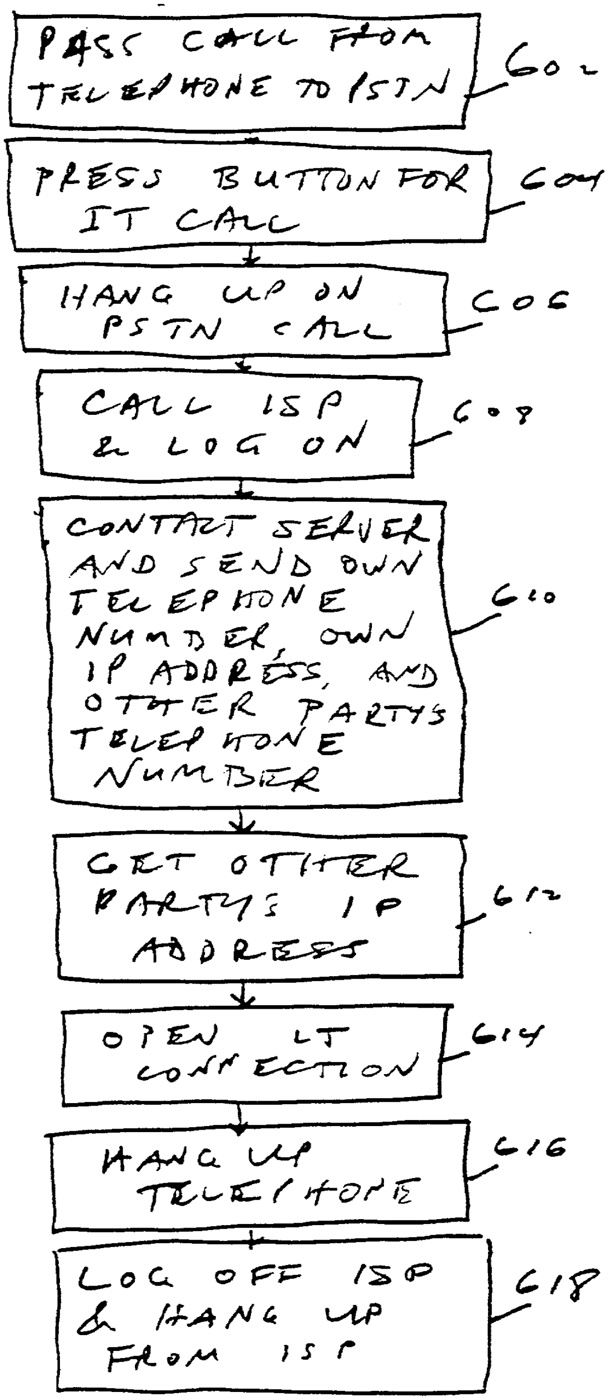

PASS CALL FROM TELEPHONE TO PSTN
602
PRESS BUTTON FOR IT CALL
604
HANG UP ON PSTN CALL
606
CALL ISP & LOG ON
608
CONTACT SERVER AND SEND OWN TELEPHONE NUMBER, OWN IP ADDRESS, AND OTHER PARTYS TELEPHONE NUMBER
610
GET OTHER PARTYS IP ADDRESS
612
OPEN IT CONNECTION
614
HANG UP TELEPHONE
616
LOG OFF ISP & HANG UP FROM ISP
618

Fig. 7A

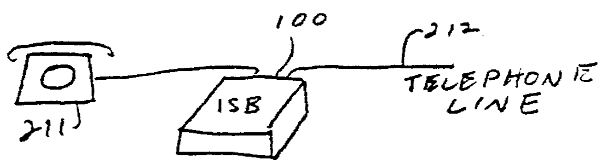



Fig. 7B

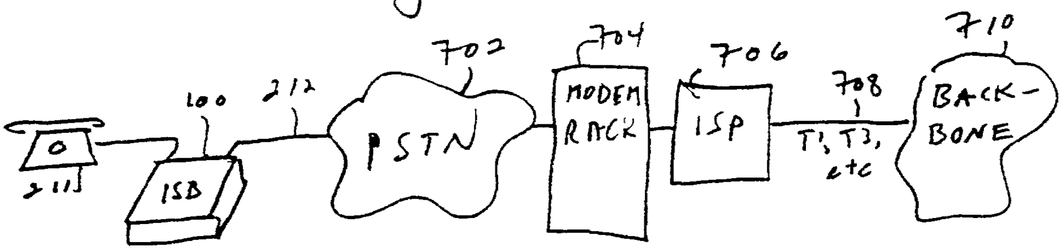



Fig. 7C

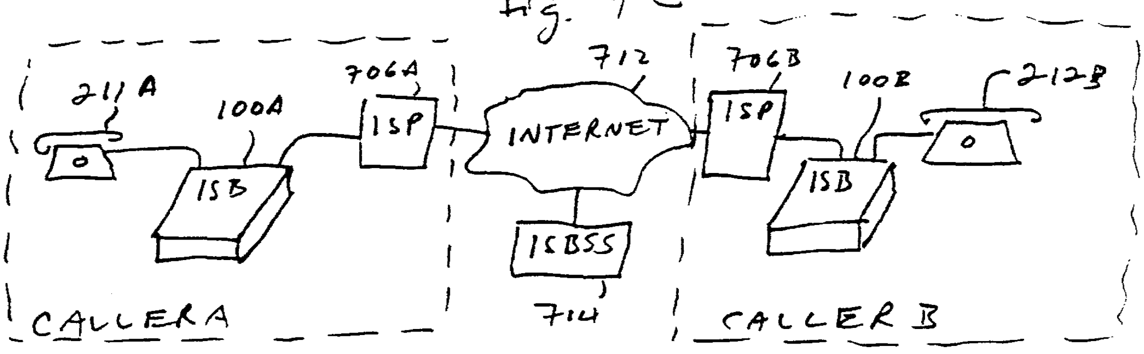


Fig. 7D

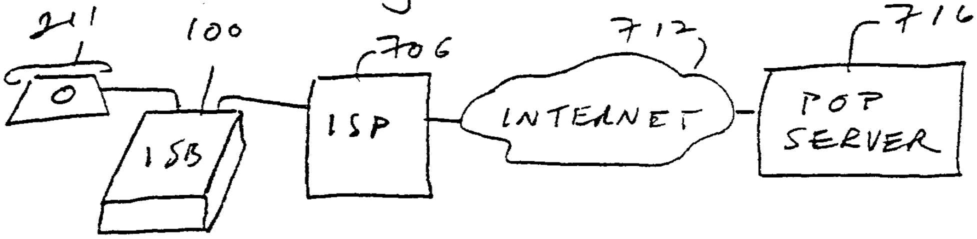

21'
100
706
712
716
ISB
ISP
INTERNET
POP
SERVER

Fig. 7 E

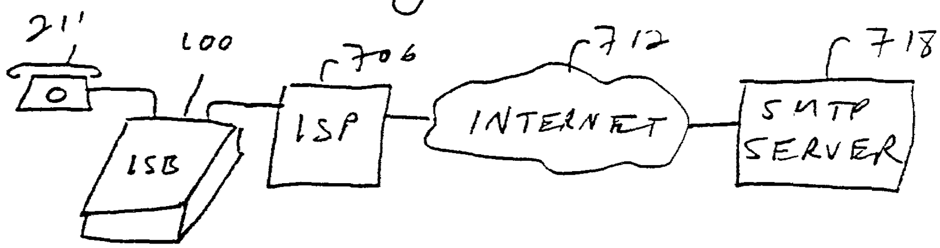

21'
100
706
712
718
ISB
ISP
INTERNET
SMTP
SERVER

Fig. 8

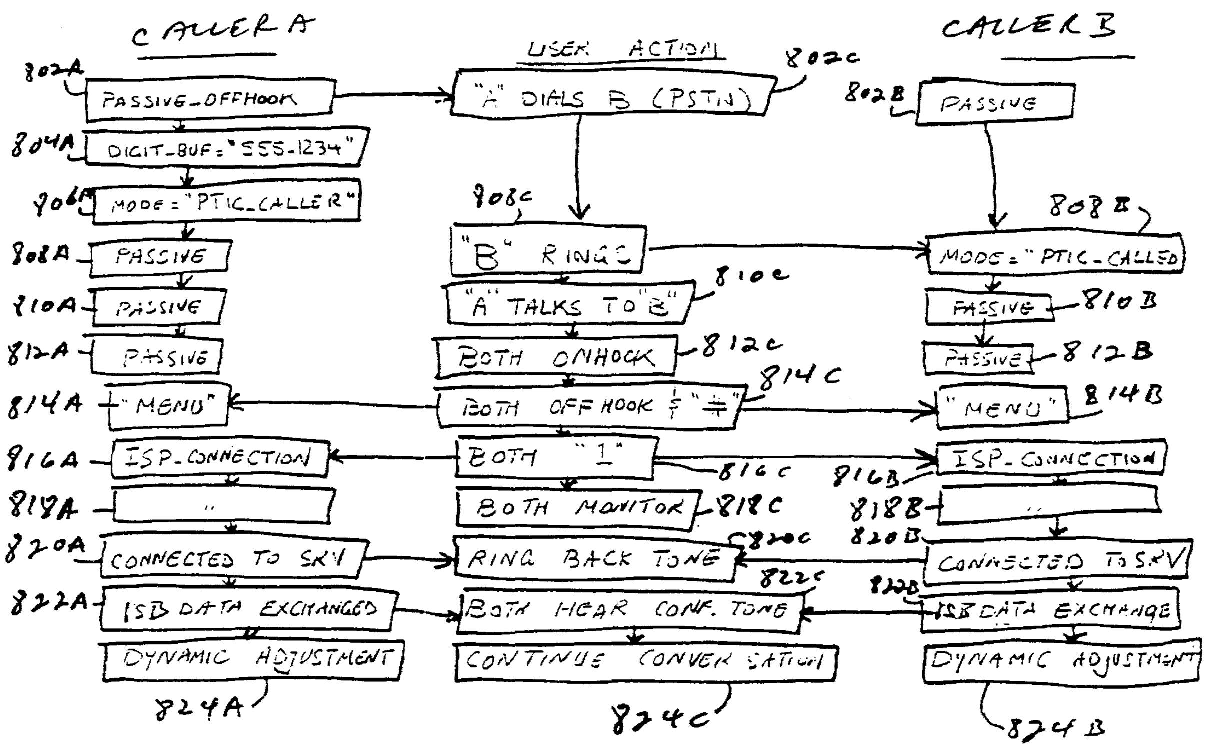
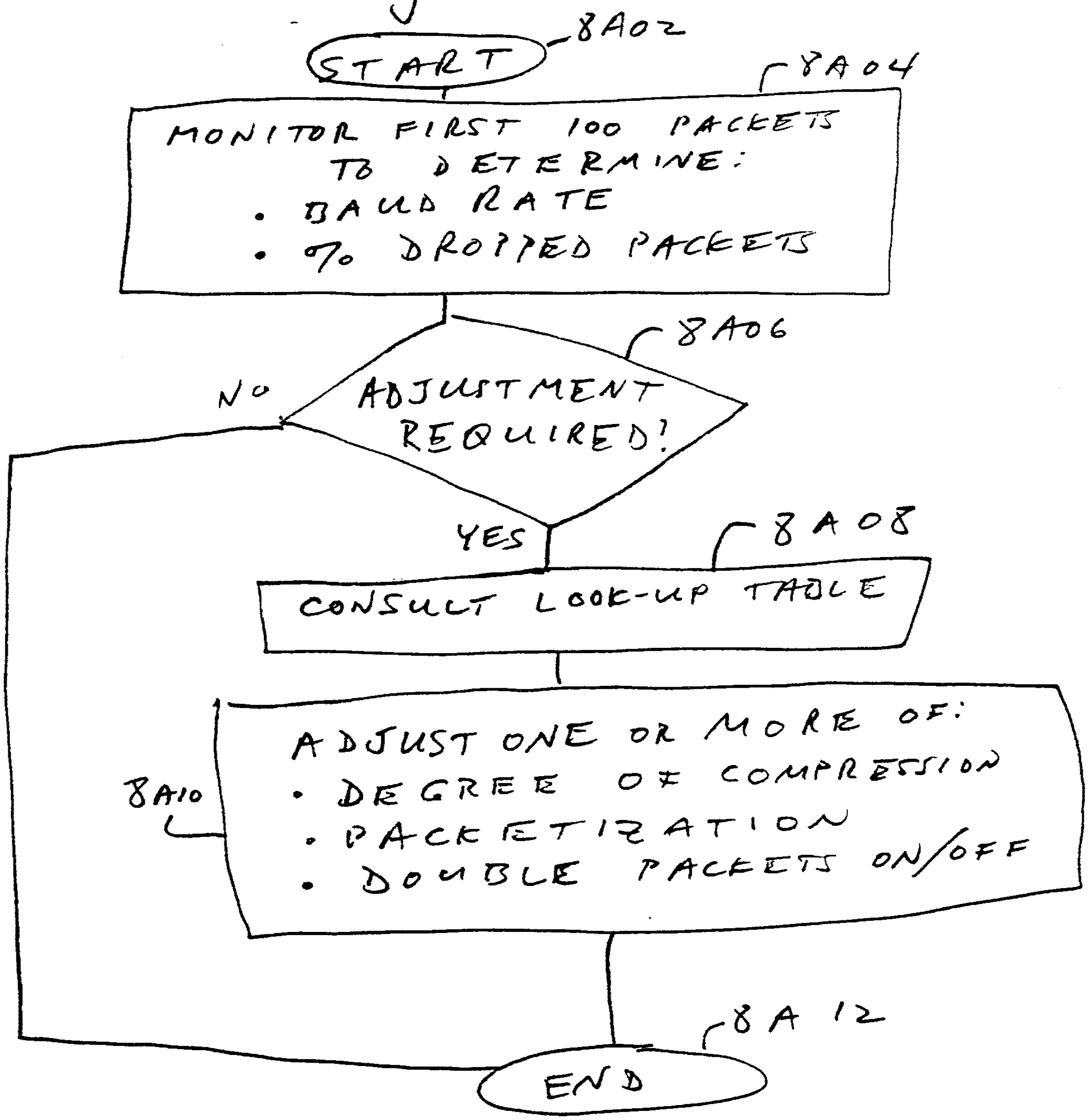

CALLER A
USER ACTION
CALLER B
802A
PASSIVE_OFFHOOK
"A" DIALS B (PSTN)
802C
802B
PASSIVE
804A
DIGIT_BUF="555-1234"
806A
MODE="PTIC_CALLER"
808C
808B
808A
PASSIVE
"B" RINGS
MODE="PTIC_CALLED"
810A
PASSIVE
"A" TALKS TO "B"
810C
PASSIVE
810B
812A
PASSIVE
BOTH ONHOOK
812C
PASSIVE
812B
814A
"MENU"
BOTH OFF HOOK & "#"
814C
"MENU"
814B
816A
ISP_CONNECTION
BOTH "1"
816C
816B
ISP_CONNECTION
818A
"
BOTH MONITOR
818C
818B
"
820A
CONNECTED TO SRV
RING BACK TONE
820C
820B
CONNECTED TO SRV
822A
ISB DATA EXCHANGED
BOTH HEAR CONF. TONE
822C
822B
ISB DATA EXCHANGE
DYNAMIC ADJUSTMENT
CONTINUE CONVERSATION
DYNAMIC ADJUSTMENT
824A
824C
824B

Fig. 8A


START
8A02
8A04
MONITOR FIRST 100 PACKETS TO DETERMINE:
• BAUD RATE
• % DROPPED PACKETS
8A06
ADJUSTMENT REQUIRED?
NO
YES
8A08
CONSULT LOOK-UP TABLE
8A10
ADJUST ONE OR MORE OF:
• DEGREE OF COMPRESSION
• PACKETIZATION
• DOUBLE PACKETS ON/OFF
8A12
END

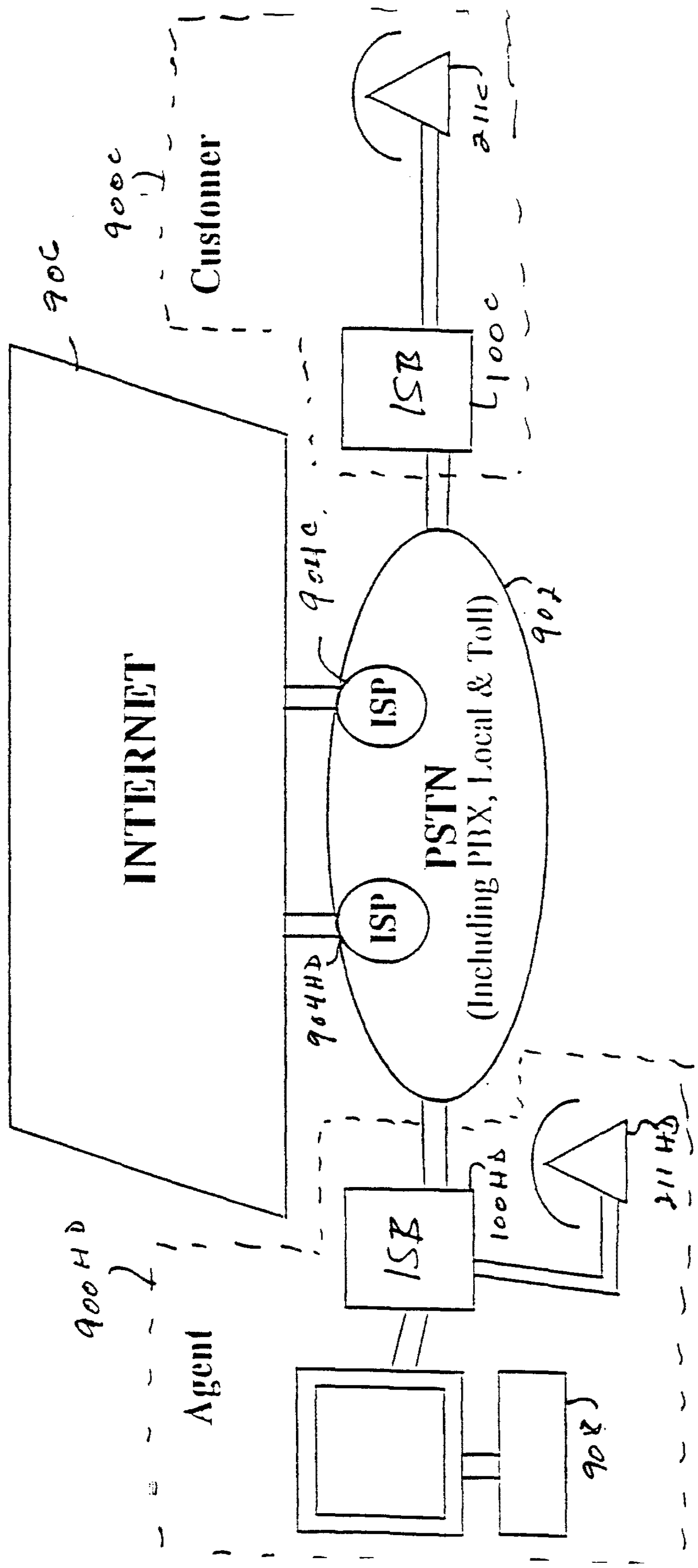

INTERNET
PSTN
(Including PBX, Local & Toll)
ISP
ISP
ISB
ISB
Customer
Agent

Fig. 9

Fig. 9A

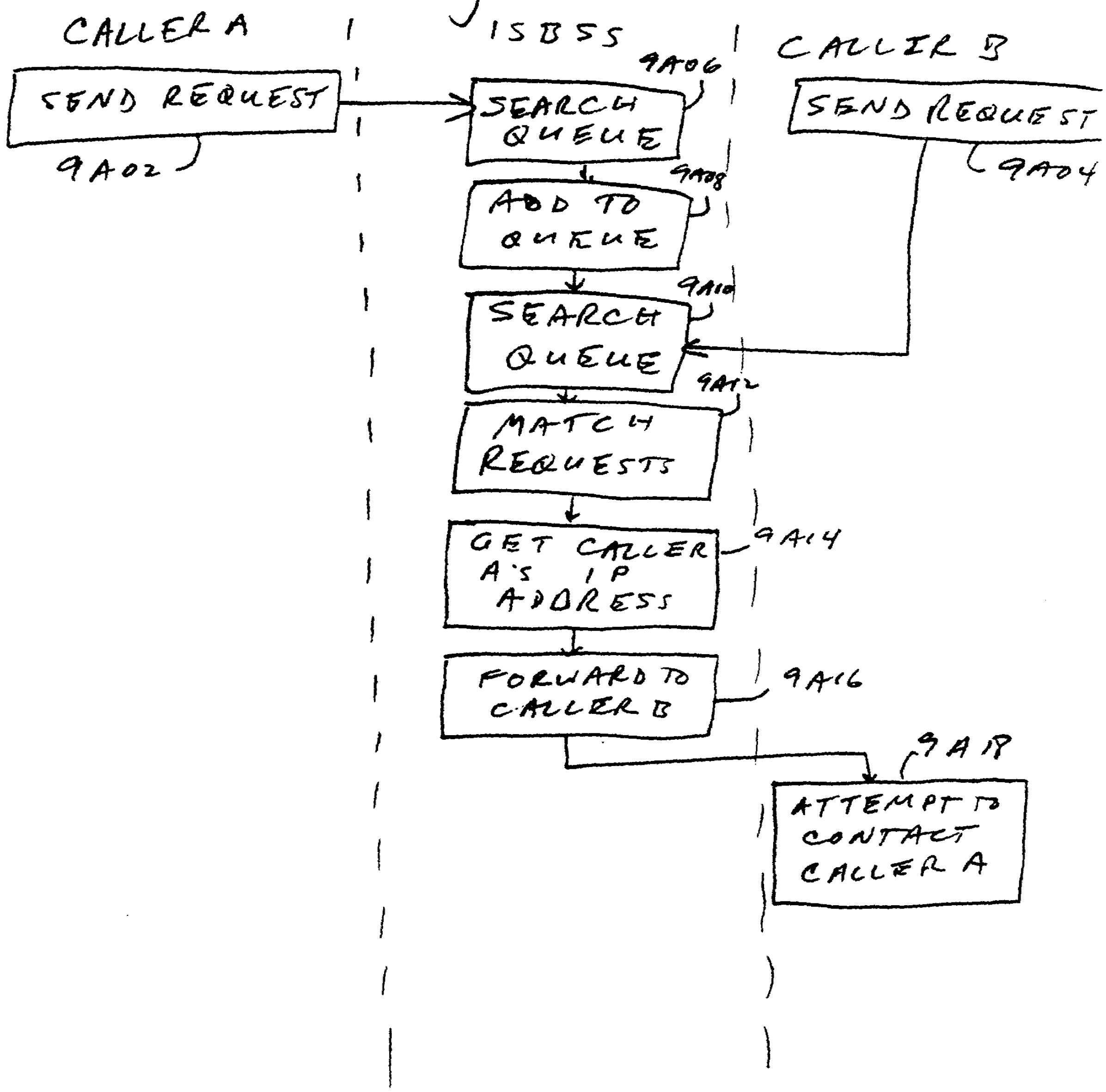

CALLER A
ISBSS
CALLER B
SEND REQUEST
9A02
SEARCH QUEUE
9A06
SEND REQUEST
9A04
ADD TO QUEUE
9A08
SEARCH QUEUE
9A10
MATCH REQUESTS
9A12
GET CALLER A's IP ADDRESS
9A14
FORWARD TO CALLER B
9A16
ATTEMPT TO CONTACT CALLER A
9A18

Fig. 10A

```
unsigned char *itobcd (unsigned int decimalNumber, unsigned int &digitCount)
/*
given an integer, produces and returns a BCD (binary-coded
decimal) string, in which each byte (unsigned char) is logically split
into two 4-bit "nibbles", each of which contains one digit of the
original integer.  Also returned as an argument-by-reference is the
number of digits found in the original integer, which is useful for
later manipulations.

The most significant digit of the original integer is stored "first",
i.e. in the high-order nibble of the leftmost byte of the BCD string.

In the current implementation, (non-leading) zeroes in the original
integer are stored as hex digit 'A' (0xA) in order to distinguish them
from "blank" or "filler" nibbles and/or bytes, which actually contain
zeroes.
*/

{
   // these are static to reduce repeat memory allocation-- for FoneFriend

  static int numOfBytes;              // bytes needed to store it as BCD

  static int numOfDigits;             // for internal use only!
  static unsigned char *BCDbuf;       // the return value goes here
  static unsigned char *bytePtr;      // moving pointer for loading BCDbuf...
  static char BitShift;               // used for decimal-to-hex conversion
  static char BCDdigits[10] =            // this allows us to do tricks like
    { 0xA, 1, 2, 3, 4, 5, 6, 7, 8, 9 };  //  storing digit 0 as 0xA

   // figure out the number of digits in 'decimalNumber'
  numOfDigits = log10((double ) decimalNumber) + 1;
  if (numOfDigits <= 0)
    return NULL;
  digitCount = numOfDigits;   // digitCount is returned to the user

  numOfBytes = (int ) ceil((double ) numOfDigits / 2.0);


   // set up storage and pointers accordingly
  BCDbuf = new unsigned char[numOfBytes];
  bytePtr = &BCDbuf[numOfBytes-1];

   // clear out the contents of BCDbuf-- correct functioning depends on this
  bzero(BCDbuf, numOfBytes);
```

Fig. 10B

```
  // we are storing BCD digits from most to least significant, going
  // left to right; and there are two digits per byte.  If there are
  // an odd number of digits to store, then the least significant decimal
  // digit will wind up in the HIGH-order nibble of the last (rightmost)
  // byte used; if there are an even number of digits, this last digit
  // will end up in the LOW-order nibble of the last byte.  Since we start
  // by storing the least significant decimal digit and move backwards,
  // we have to know right away which nibble to put it in.  QED.
if (numOfDigits % 2)       // we have an odd number of digits
  BitShift = 4;            // start in high-order nibble (left-shift 4 bits)
else BitShift = 0;         // start in low-order nibble (no shift)


while (numOfDigits--) {  // we have at least one more digit to do

    // get the last digit of 'decimalNumber' and put it in the
    // appropriate nibble
  *bytePtr += (BCDdigits[decimalNumber % 10] << BitShift);


    // now, we need to get ready to deal with the next digit.
    // crafty code alert!  BitShift can have the values 0 and 4; if it
    // is currently 0, then we just handled the LOW-order nibble of a
    // byte, and we will stay within this byte to do the next digit.
    // But if BitShift is currently 4, we just did the HIGH-order byte
    // and we can move back to the previous byte.  The following
    // very confusing code does that for you:
  bytePtr -= (BitShift / 4);

    // of course, the value of BitShift must now be toggled:

   BitShift = 4 - BitShift;

     // finally, we line up 'decimalNumber' to deal with the next digit
     // in line, by way of throwing away the last digit we looked at, which
     // was the least significant digit of 'decimalNumber'.
   decimalNumber /= 10;
     // at long last, we're ready to copy the digit into the BCD string:
   //    *bytePtr += (BCDdigits[decimalNumber % 10] << BitShift);

 }

 return BCDbuf;
}
```

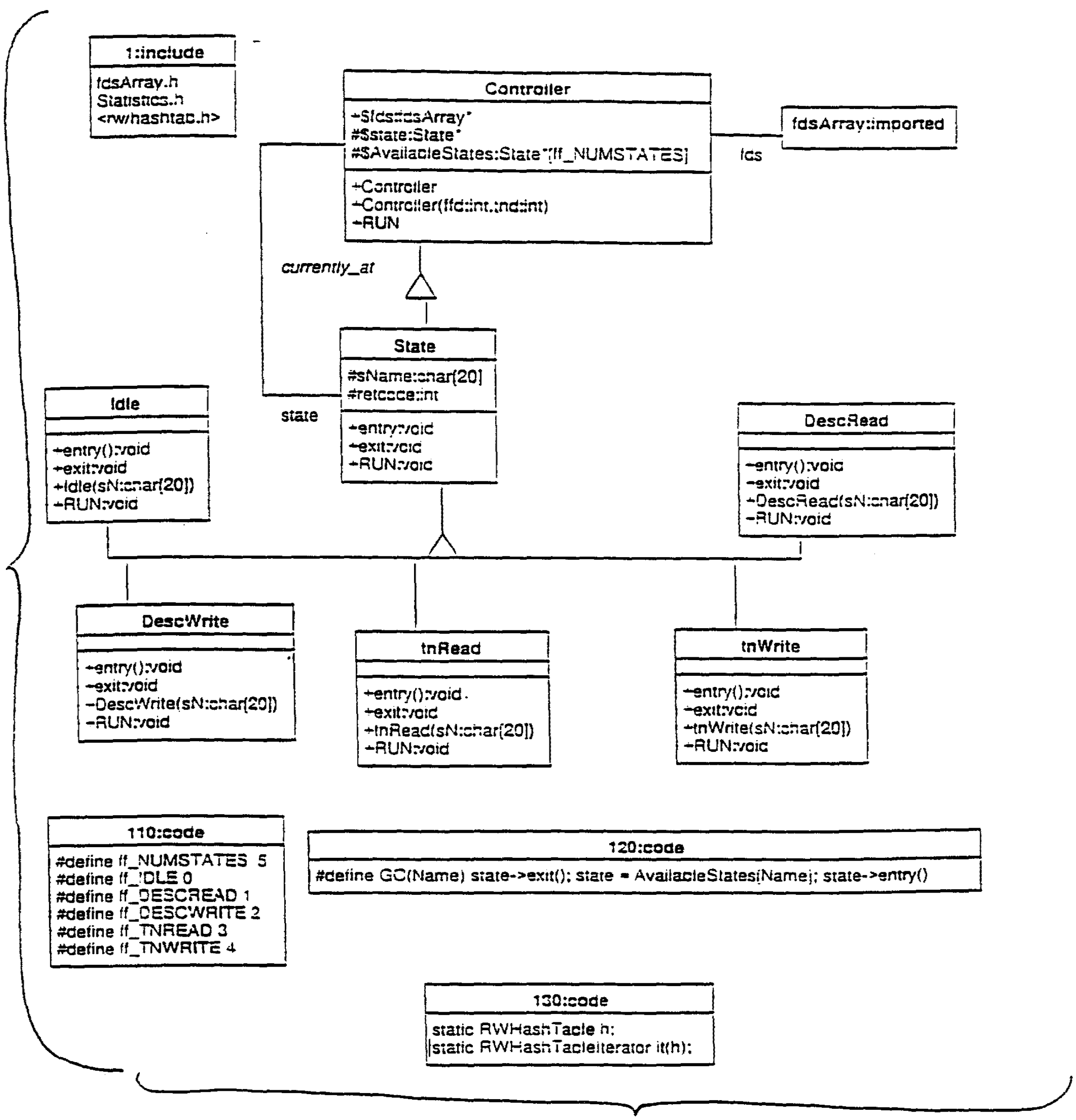

1:include
fdsArray.h
Statistics.h
<rw/hashtab.h>
Controller
+Sfds:fdsArray*
#$state:State*
#$AvailableStates:State*[ff_NUMSTATES]
+Controller
+Controller(ffd:int,tnd:int)
+RUN
fdsArray::imported
fds
currently_at
State
#sName:char[20]
#retcode:int
+entry:void
+exit:void
+RUN:void
state
Idle
+entry():void
+exit:void
+Idle(sN:char[20])
+RUN:void
DescRead
+entry():void
+exit:void
+DescRead(sN:char[20])
+RUN:void
DescWrite
+entry():void
+exit:void
+DescWrite(sN:char[20])
+RUN:void
tnRead
+entry():void
+exit:void
+tnRead(sN:char[20])
+RUN:void
tnWrite
+entry():void
+exit:void
+tnWrite(sN:char[20])
+RUN:void
110:code
#define ff_NUMSTATES 5
#define ff_IDLE 0
#define ff_DESCREAD 1
#define ff_DESCWRITE 2
#define ff_TNREAD 3
#define ff_TNWRITE 4
120:code
#define GO(Name) state->exit(); state = AvailableStates[Name]; state->entry()
130:code
static RWHashTable h;
static RWHashTableIterator it(h);

Fig. 11

Fig. 11A

```
typedef struct {
  unsigned short struct_type;
    // tells us how to interpret the tx_data
    // 1001  t_ConnectPacket
    // 1002  t_RxConnectPacket
  unsigned short len;  // length of data in tx_data
  char tx_data[252];   // 252 bytes to handle future expansion
} tx_packet;
```

Fig. 11 B

```
typedef struct {
      unsigned char  hw_version; // identifies the originator of this struct
    unsigned char  sw_version; // 1 == 1st version
       // the connection type should be the first bytes read.
       // the types are:
       //        1 - caller non-1st time
       //        2 - called
       //        3 - caller 1st time
       //        4 - mmic
       //        5 - message
       //        7 - self-test
       //        8 - upgrade request
     unsigned short int connect_type;
     unsigned char my_phone_num[8];
     unsigned char his_phone_num[8];
     unsigned long my_serial_num;
     unsigned long his_serial_num;
     unsigned char my_ip[4];
     t_BillingData bill_rec;
  } t_ConnectPacket;
```

Fig. 11 C

```
 typedef struct {
     unsigned long start_time; // start time of previous service
     unsigned long stop_time;  // duration (in seconds) of previous service
     unsigned char phone[8];   // phone number of previous call
    unsigned char stat_data[8]; // statistical data about previous service
 } t_BillingData;
```

Fig. 11 D

```
typedef struct {
  unsigned short struct_type;
     // tells us how to interpret the tx_data
     // 1001  t_ConnectPacket
     // 1002  t_RxConnectPacket
  unsigned short len;  // length of data in tx_data
  char tx_data[252];   // 252 bytes to handle future expansion
} tx packet;
```

Fig. 11 E

```
typedef struct {
  // New fields added to allow for commands
  unsigned char pckt_type;  // 0 == message, 1 == error
  unsigned char me_type;
     // messages:
     // 0 = return usable IP addr,
     // 1 = no match; IP == 0.0.0.0,
     // 2 = go to another server; IP address given
     // 3 = no action to take (response to message or self-test; IP == 0.0.0.0)
     // errors:
     // 0 = problem on my end; retry from scratch
     // 1 = problem with your data; retry from scratch
     // 2 = you are not an active user of the requested FF Service.
  unsigned char commandType;

     // 0 == no command
     // 1 == contact command server for further commands
     //        send new IP addr in command
     // 2 == set Update Available light on
     // 3 == unset Update Available light
     // 4    new main server
     //        send new IP addr in command
     // 5 == new backup server
     //        send new IP addr in command
   unsigned char commandSize;  // number of bytes found in command[]
   unsigned char his_ip[4];
   unsigned long cur_time;
   char command[32];
     // If commandSize <= 28 we can rely on
     // bytes command[28] .. command[31] containing the
     // sender serial number just for debugging purposes.
     // we have not specified what a command looks like.
     // commandType == 2:
     //   commandSize = 8, command = "10 2 1\r\n"
     // commandType == 4:
     //   commandSize = 21, command = "0 1 0 137 140 7 222\r\n"
     // commandType == 21;
     //   commandSize = 8, command = "0 1 1 137 140 7 222\r\n"
} t_RxConnectPacket;
```

Fig. 11 F

```
********** Results from generation of Statistics **********

***** Absolute Value Counters *****
  m Entered Idle state            : 985131
  m FFServer connection Requests: 0
  m Entered DescRead state        : 0
  m Entered DescWrite state       : 0
  m DescRead ok                   : 0
  m DescRead failed: wrong size : 0
  m DescRead failed: disconnect : 0
  m DescRead failed: orderly rel: 0
  m DescWrite ok                  : 0
  m DescWrite failed              : 0
  m Init New Descriptor           : 1
  m Conn discon in complete list: 0
  m Invalid Client Port           : 0
  m Entered Housekeeping          : 985099
  m Completed Connection RQ       : 0
  m Expired Connection RQ         : 0
  m inactive Connection RQ        : 0
  m tnClient Write ok             : 29
  m tnClient Write failed         : 0
  m Serial Number Invalid         : 0
***** Maximum Value Counters *****
  m Max Complete Connection Q     : 0
  m Max Stack Size                : 0
  m Max Connection List Size      : 0
***** Minimum Value Counters *****
  m Min Stack Size                : 2147483647
  m Min Connection List Size      : 0
********** End of StatisticsReport **********

Monitoring Stopped
```

Fig. 11 G

```
Mon Feb 23 13:06:31 1998> New logged session of FFServer

Mon Feb 23 13:06:31 1998> Number of Invalid Serial Numbers: 1000
Mon Feb 23 13:06:55 1998> New TNClient (IP.Port): 137.140.8.104.36239
Mon Feb 23 13:07:55 1998> Closing  TNClient (IP.Port): 137.140.8.104.36239
Mon Feb 23 13:07:56 1998> (CL) Unknown ConnectType (IP.Port): 137.140.8.104.36239
Mon Feb 23 13:07:57 1998> (CL) Wrong Packet Size  (IP.Port): 137.140.8.104.36239
Mon Feb 23 13:07:58 1998> (CL) PcktType != 1001  (IP.Port): 137.140.8.104.36239
Mon Feb 23 13:07:59 1998> (CL) tx_packetPtr was NULL  (IP.Port): 137.140.8.104.36239
Mon Feb 23 13:07:60 1998> (CL) Failed on attempt to insert  (IP.Port): 137.140.8.104.36239
```

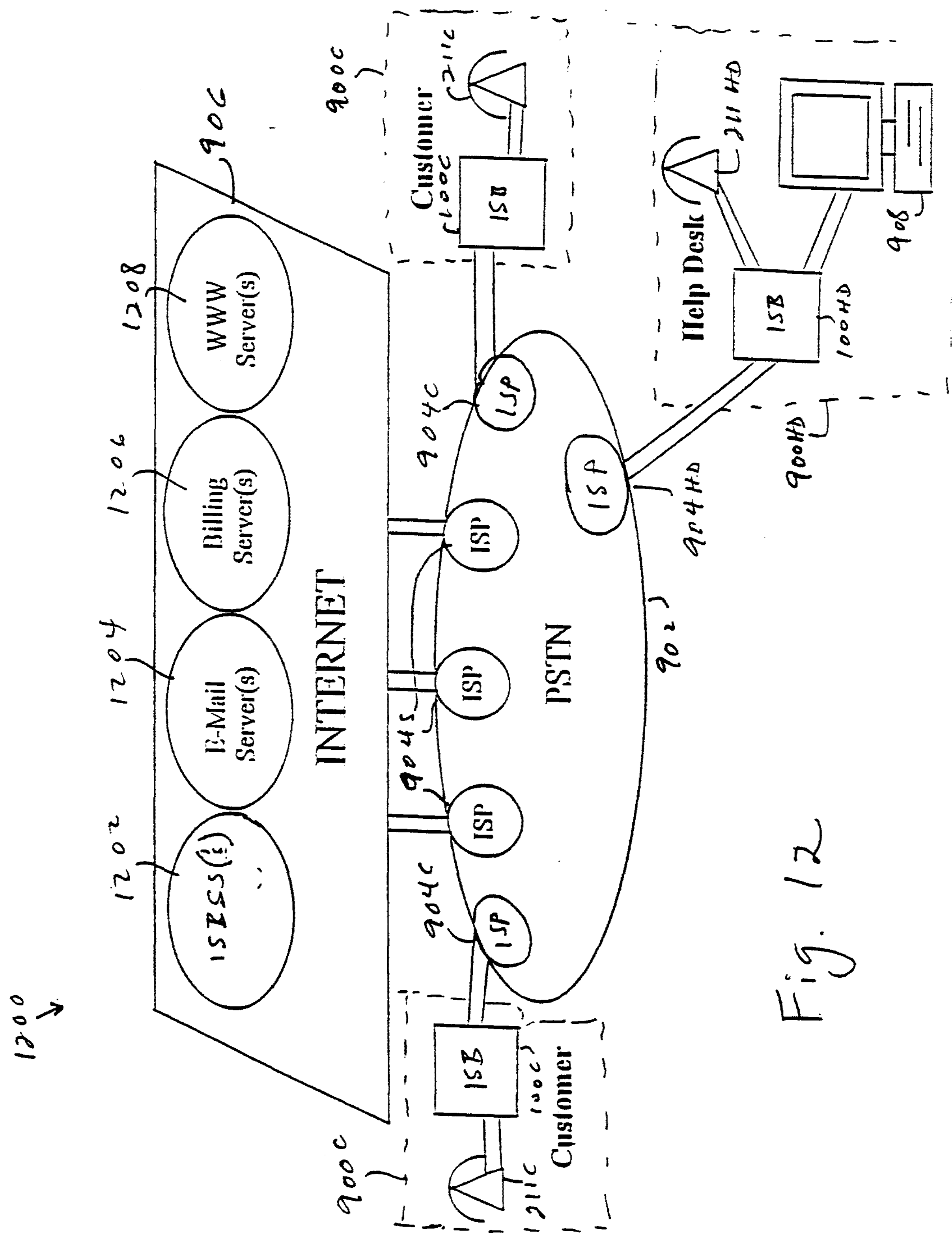
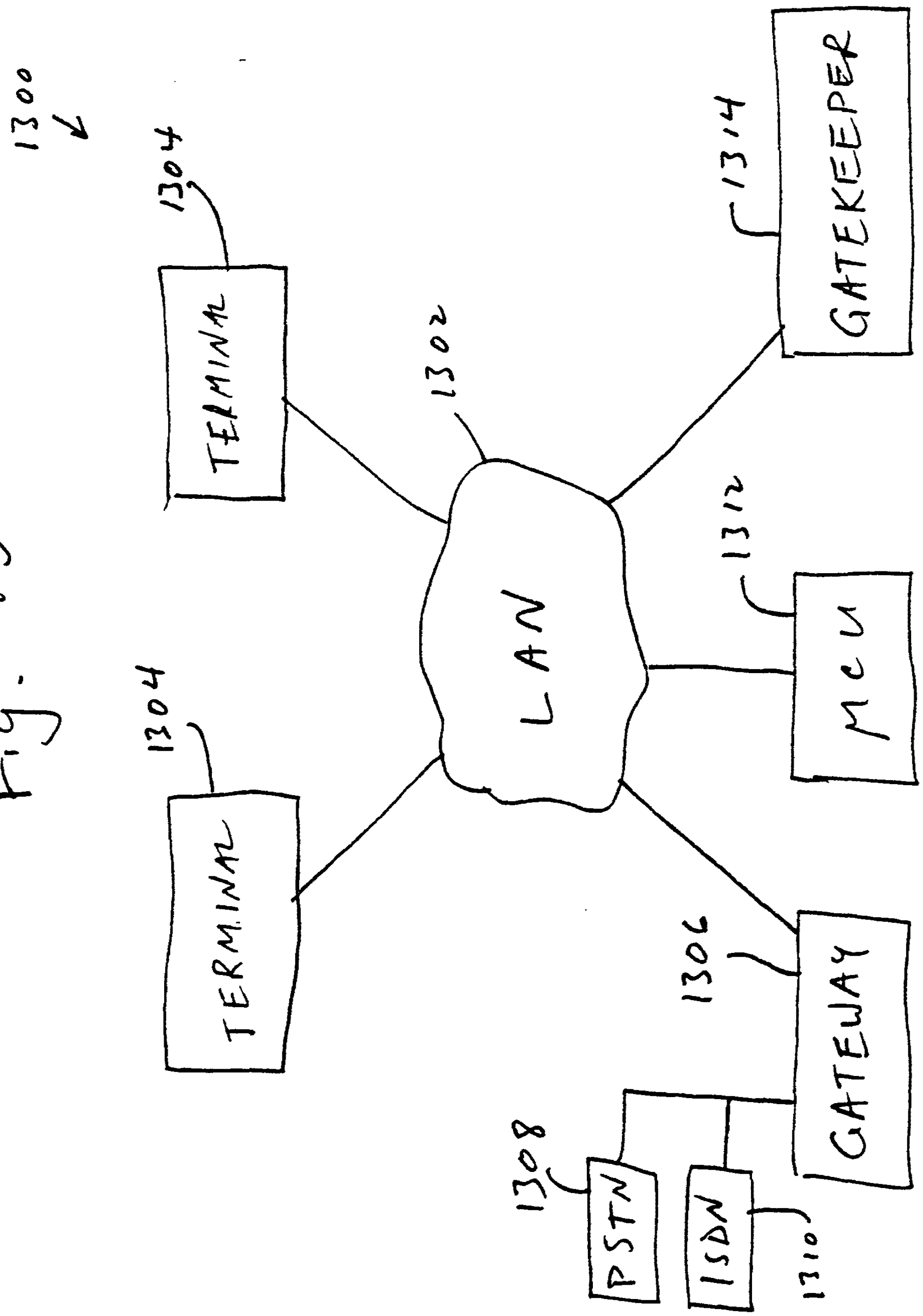

1200
INTERNET
906
ISBSS(i)
1202
E-Mail Server(s)
1204
Billing Server(s)
1206
WWW Server(s)
1208
PSTN
902
ISP
ISP
ISP
ISP
ISP
ISP
904C
904S
904S
904C
904HD
Customer
ISB
100C
211C
900C
Customer
ISB
100C
211C
900C
Help Desk
ISB
100HD
211HD
908
900HD

Fig. 12

Fig. 13


1300
TERMINAL
1304
TERMINAL
1304
LAN
1302
GATEKEEPER
1314
MCU
1312
GATEWAY
1306
PSTN
1308
ISDN
1310

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/03630

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) :H04L 12/28, 12/56
US CL :370/352
According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS (PSTN, Internet telephony, switch boxes, ISP, Internet service provider, Internet protocol, Internet)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US 5,473,676 A (FRICK et al) 05 December 1995, col. 3, line 37 to col. 4, line 3. | 1-10 |
| Y | US 5,553,122 A (HABER et al) 03 September 1996, col. 2, lines 12-61) | 1-10 |
| A, P | US 5,608,786 A (GORDON) 04 March 1997. | 1-52 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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| 03 JUNE 1998 | 06 AUG 1998 |

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| Commissioner of Patents and Trademarks<br>Box PCT<br>Washington, D.C. 20231 | JASON CHAN |
| Facsimile No. (703) 305-3230 | Telephone No. (703) 305-3900 |

Form PCT/ISA/210 (second sheet)(July 1992)★

B. FIELDS SEARCHED
Minimum documentation searched
Classification System: U.S.

370/352, 383, 389, 390, 392, 401, 408, 410; 379/ 89, 90.01, 93.01, 93.07, 93.08, 93.14, 93.23, 93.29, 100.11, 100.13, 114, 201, 220

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

| | | |
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(71) Applicant *(for all designated States except US)*: TELIA AB (publ) [SE/SE]; Mårbackagatan 11, S-123 86 Farsta (SE).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: HYLLANDER, Klas [SE/SE]; Ruddammsvägen 41, 4tr, S-114 21 Stockholm (SE). WINROTH, Mats, Olof [SE/SE]; Lyckogången 4, S-135 54 Tyresö (SE).

(74) Agent: PRAGSTEN, Rolf; Telia Research AB, Corporate Patent Dept., Vitsandsgatan 9, S-123 86 Farsta (SE).

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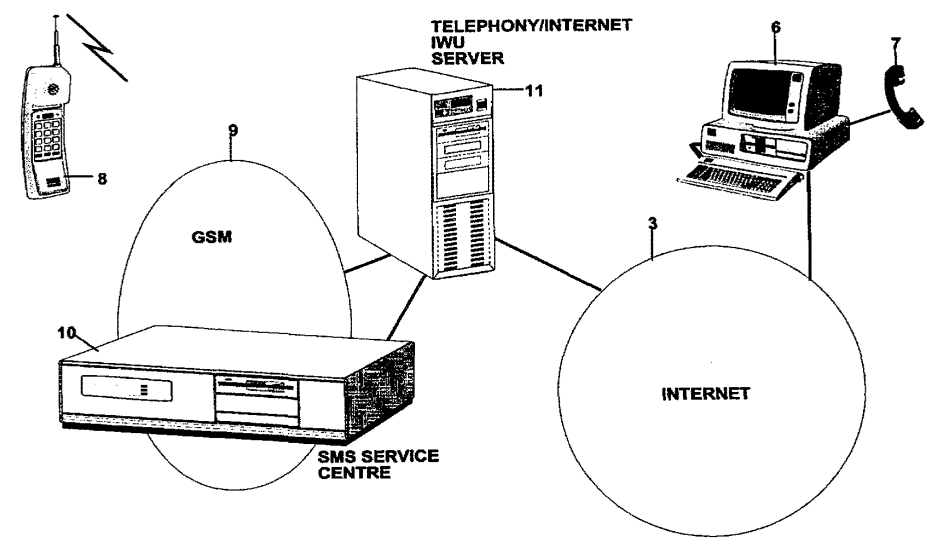
**Published**
*With international search report.*

(54) Title: COMMUNICATION SYSTEM INCLUDING MEANS FOR TRANSMITTING INTERNET ADDRESSES VIA SMS




(57) Abstract

The invention provides a communication system, adapted to establish connections to, and between, Internet users, including a cellular radio communication network adapted to provide a short message service (SMS), and a server adapted to facilitate the establishment of a telephony/Internet connection between a mobile subscriber station of said network and an Internet user. SMS is used to transfer, from the mobile subscriber station to the server, information identifying the Internet address for the Internet user and, from the server to the mobile subscriber station, information relating to the required connection between the mobile subscriber station and the Internet user.

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# Communication system including means for transmitting internet addresses via SMS

The invention relates to a communication system including a cellular radio communication network, such as a Global System for Mobile Communication (GSM) network, that is adapted to enable a GSM subscriber to make an Internet telephone call to an Internet user. In particular, a 'short message service' (SMS) is used to transfer address information for the Internet user to an Internet server. The invention also relates to a method for enabling a GSM subscriber to make an Internet telephone call to an Internet user using SMS to transfer address information for the Internet user.

It is highly probable that, within a few years, a very large proportion of the population of, for example, Sweden, will use the Internet in their day-to-day activities for a number of purposes, including, inter alia:

- entertainment;
- electronic shopping/banking;
- retrieving information in respect of a wide range of subject matter;
- as an information bank; and
- person-to-person communication.

At the present time, e-mail is the major Internet application, but it would clearly be of advantage to telephone subscribers if Internet telephony became, in the long term, a readily available subscriber service for personal communication. Forecasts envisage that Internet traffic, as compared with present day levels, could be increased many times by telephony. For a telephone operator, this is a development which, although it could reduce revenues, will give rise to major developments in, and/or opportunities for, new subscriber services.

At the present time, a number of different Internet telephony solutions are currently available and in commercial operation.

The main advantage of known Internet telephony services is that the cost of long-distance calls can be considerably reduced. This cost reduction is effected by using local access points for the telephone calls and by using the Internet for the long-range transportation/transmission of telephone traffic. Services already launched include, inter alia:

- telephony from Internet-connected users to PSTN (Public Switched Telephone Network) subscribers, in which the PSTN subscriber is called by a local interworking server;

- a service in which both A-subscribers and B-subscribers are PSTN-connected to local servers which have contact with each other via the Internet - it will be seen from the subsequent description of the present invention that, in the longer term, it will also be able to be transmit speech via GSM in the same manner.

The mobile cellular radio communication network, known as GSM, which is covered by standards developed and promulgated by the European Telecommunications Standards Institute (ETSI), offers a variety of services to users, other than voice, including, inter alia, data services, short message services, and broadcast services. The ETSI GSM Standards specify, in addition to the radio interface, a complete telecommunications network with radio access by the user. Since the architecture, and operational aspects, of GSM are well known to persons skilled in the art, only those aspects of GSM which are of direct relevance to the present invention will be described in this patent specification.

Thus, a GSM mobile connection is distinguished from a conventional PSTN connection in that the mobile station, apart from having access to speech services, can access a short message service (SMS).

SMS is a feature which is incorporated into digital mobile telephone networks, and can be divided into two types, point-to-point services (SMS-PP), and broadcast services (SMS-CB).

SMS-PP allows a brief message (up to 160 characters) to be sent between a mobile telephone and a Service Centre (SC). Larger messages can optionally be created by concatenating multiple messages (the protocol allows up to 10 messages to be concatenated in this way). The SC is adapted to send, or receive, messages from a wide variety of sources, in addition to a GSM mobile telephone, for example, fax, normal telephone, dial up modems, public, or private data networks etc.. This means that the service is not limited to sending messages between GSM mobile telephones, but can be used to send, or receive, messages from the wider telecommunications network.

An advantage of using SMS, in the present invention, is that it can be used by a GSM subscriber to establish a telephone connection to an Internet-connected user, without any additional equipment being necessary.

It is an object of the present invention to provide a communication system including a cellular radio communication network, such as a Global System for Mobile Communication (GSM) network, that is adapted to use a short message service (SMS) to enable a GSM subscriber to make an Internet telephone call to an Internet user. In particular, SMS is used to transfer address information for the Internet user to an Internet server.

It is another object of the present invention to provide a method for enabling a GSM subscriber to make an Internet telephone call to an Internet user using SMS to transfer address information for the Internet user.

According to a first aspect of the present invention, there is provided, a communication system adapted to establish connections to, and between, Internet users, characterised in that said communication system includes a cellular radio communication network adapted to provide a short message service (SMS), and a server adapted to facilitate the establishment of a telephony/Internet connection between a mobile subscriber station of said network and an Internet user, and said SMS is adapted to transfer, from said mobile subscriber station to said server, information identifying the Internet address for said Internet user; and, from said server to said mobile subscriber station, information relating to said connection between said mobile subscriber station and said Internet user.

SMS may be used to transfer the following information to said telephony/Internet server:

(a) the Internet address for an Internet-connected computer terminal of said Internet user; and

(b) a specific identity for said mobile subscriber station, for example, a telephone number for said mobile subscriber station.

The telephony/Internet server may include analysing means for effecting, on receipt of said SMS-transferred information, an A-number analysis to determine the A-telephone number identity of said mobile subscriber station.

The telephony/Internet server may be adapted, in response to receipt of said SMS-transferred information from said mobile subscriber station, to send an SMS to said mobile subscriber station including the following information:

(a) that call connection to said Internet user is possible; and

(b) the server's telephone number.

The telephony/Internet server may be adapted, on receipt of a call from said mobile subscriber station, made using the server's telephone number, to identify said mobile subscriber station (calling party), associate the telephone call with the Internet address previously transferred to said server by said mobile subscriber station, and connect the telephone call to the Internet address.

The telephony/Internet server may be adapted to identify said mobile subscriber station (calling party) using said A-number analysing means. The Internet address may be associated with the A-telephone number of said mobile subscriber station for a specific period of time which is monitored by a system timer.

The telephony/Internet server may be adapted to connect the telephone call either directly to the Internet address, or to the Internet address via at least one additional Internet server, a server at the end of this chain being adapted to provide Internet telephony services.

The telephony/Internet server may include means for establishing and storing a list of Internet addresses for each mobile subscriber station user subscribing to the system, and each one of said Internet addresses may have an address list number.

The telephony/Internet server may be adapted, in response to receipt of said SMS-transferred information from said mobile subscriber station, to send an SMS to said mobile subscriber station including the following information:

(a) that call connection to said Internet user is possible;

(b) the server's telephone number; and

(c) an address list number for the Internet address, each address list number corresponding to one of the Internet addresses in the mobile subscriber station user's address list in the telephony/Internet server.

The address list numbers may be stored in a respective mobile subscriber station's telephone number list.

The mobile subscriber station may be adapted to request from said telephony/Internet server, and said telephony/Internet server may be adapted to supply to the mobile subscriber station, a complete listing of the Internet address list.

The mobile subscriber station may be adapted to search for a specific one of the

Internet addresses stored by said telephony/Internet server.

The telephony/Internet server may be adapted, on receipt of a call connection request from a mobile subscriber station to an unlisted Internet address, to store, and assign an address list number to, the unlisted Internet address, and send back, to the mobile subscriber station, via SMS, the following information to enable a user of said mobile subscriber station to call said Internet address:

(a) the assigned address list number;

(b) the server's telephone number; and

(c) information that call connection is possible to the Internet address.

According to a second aspect of the present invention, there is provided, a method for enabling a mobile subscriber station of a cellular radio communication network to make an Internet telephone call to an Internet user, characterised by the use of SMS to transfer, from said mobile subscriber station to a telephony/Internet server, information identifying the Internet address for said Internet user; and, from said telephony/Internet server to said mobile subscriber station, information relating to said connection between said mobile station and said Internet user. This method may be further characterised by said SMS being used to transfer the following information to said telephony/Internet server: the Internet address for an Internet-connected computer terminal of said Internet user; and a specific identity for said mobile subscriber station, for example, a telephone number for said mobile subscriber station.

The method may be characterised by said telephony/Internet server, on receipt of said SMS-transferred information, using A-number analysis to determine the A-telephone number identity of said mobile subscriber station.

The method may be characterised by said telephony/Internet server, in response to receipt of said SMS-transferred information from said mobile subscriber station, sending an SMS to said mobile subscriber station including the following information:

that call connection to said Internet user is possible; and the server's telephone number.

The method may be characterised by said mobile subscriber station calling the server's telephone number, and said server, on receipt of the call from said mobile subscriber station, identifying said mobile subscriber station (calling party), associating the telephone call with the Internet address previously transferred to said server by said mobile subscriber station, and connecting the telephone call to the Internet address. This method may be further characterised by said telephony/Internet server identifying said mobile subscriber station (calling party) using said A-number analysis.

The method may be characterised by associating said Internet address with the A-telephone number of said mobile subscriber station for a specific period of time, and by monitoring said period of time.

The method may be characterised by said telephony/Internet server connecting the telephone call either directly to the Internet address, or to the Internet address via at least one additional Internet server, a server at the end of this chain being adapted to provide Internet telephony services.

The method may be characterised by said telephony/Internet server establishing and storing a list of Internet addresses for each mobile subscriber station user wishing to make Internet telephone calls, and by each one of said Internet addresses having an address list number. This method may be further characterised by said telephony/Internet server, in response to receipt of said SMS-transferred information from said mobile subscriber station, sending an SMS to said mobile subscriber station including the following information: that call connection to said Internet user is possible, the server's telephone number, and an address list number for the Internet address, each address list number corresponding to one of the Internet addresses in the mobile subscriber station user's address list in the telephony/Internet server. This method may be further characterised by storing said address list numbers in a respective mobile subscriber station's telephone number list.

The method may be characterised by a mobile subscriber station requesting a complete listing of the Internet address list from said telephony/Internet server.

The method may be characterised by a mobile subscriber station searching for a specific one of the Internet addresses stored by said telephony/Internet server.

The method may be characterised by said telephony/Internet server, on receipt of a call connection request from a mobile subscriber station to an unlisted Internet address, storing, and assigning an address list number to, the unlisted Internet address; and by sending back, to the mobile subscriber station, via SMS, the following information to enable a user of said mobile subscriber station to call said Internet address: the assigned address list number, the server's telephone number, and information that call connection is possible to the Internet address.

According to a third aspect of the present invention, there is provided, a method for enabling a mobile subscriber station of a cellular radio communication network to make an Internet telephone call to an Internet user, characterised by a user of said mobile subscriber station sending the following information to a telephony/Internet server using SMS: information identifying the Internet address for said Internet user, and the specific identity of said mobile subscriber station (for example, the telephone number for the mobile subscriber station); said telephony/Internet server, in response to receipt of said information, sending an SMS to said mobile subscriber station, said SMS including the following information: that connection to said Internet address is possible, and the server's telephone number; a user of said mobile subscriber station, on receipt of the SMS from the server, calling the server's telephone number; and the server, on receipt of the telephone call from the mobile subscriber station, identifying the calling party (mobile subscriber station) using, for example, A-number analysis, associating the telephone call with the Internet address previously received in the SMS from the mobile subscriber station; and connecting the telephone call to the Internet address.

According to a fourth aspect of the present invention, there is provided, a method for enabling a mobile subscriber station of a cellular radio communication network to make an Internet telephone call to an Internet user, characterised by establishing and storing a list of Internet addresses for each mobile subscriber station user wishing to make Internet telephone calls; assigning, for each address in the Internet address list, a number which uniquely identifies these addresses; a user of said mobile subscriber station sending the following information to a telephony/Internet server using SMS: information identifying the Internet address for said Internet user, and the specific identity of said mobile subscriber station (for example, the telephone number for the mobile subscriber station); said telephony/Internet server, in response to receipt of said information, sending an SMS to said mobile subscriber station, said SMS including the following information: that connection to said Internet address is possible, the server's telephone number, and an address list number for the Internet address, each address list number corresponding to one of the Internet addresses in the mobile subscriber station user's address list in the telephony/Internet server; a user of said mobile subscriber station, on receipt of the SMS from the server, calling the server's telephone number; the telephony/Internet server, on receipt of the telephone call from the mobile subscriber station, transmitting a voice message to said mobile subscriber station requesting the user to key in an address list number; and, when said mobile subscriber station user keys in said address list number, said telephony/Internet server connecting the user of said mobile subscriber station to an Internet user at the Internet address corresponding to the address list number. This method may be further characterised by said telephony/Internet server, in the absence of a response from the Internet user, notifying the user of said mobile subscriber terminal by means of either a voice message, or tones, as in conventional telephony. This method may be further characterised by said notification being that the Internet user is engaged, or is not replying, or does not have an Internet telephony application.

The cellular radio communication network may be a GSM network.

The foregoing and other features of the present invention will be better understood from the following description with reference to the accompanying drawings, in which:

Figure 1 diagrammatically illustrates a communication system having a number of different Internet telephony arrangements; and

Figure 2 diagrammatically illustrates a communication system according to the present invention.

It will be seen from the communication system, which is diagrammatically illustrated in Figure 1 of the accompany drawings, that:

(a) PSTN subscriber telephones 1 and 2, are respectively connectd to the Internet 3 via Telephony/Internet IWU (InterWorking Unit) Servers 4 and 5; and

(b) Internet users are connected to the Internet 3 by means of a user terminal 6 which is, in essence, a computer terminal, such as a personal computer, with a display screen and having a telephone handset 7 connected thereto. The Internet user terminal 6 is connected to the Internet 3 via a modem (not illustrated) and includes appropriate Internet software for facilitating the establishment of a connection to, and interaction with, the Internet 3.

In practice, a PSTN subscriber telephone, in Figure 1, could be replaced by a GSM mobile station/handset and a GSM network, in which case, a MSC (Mobile Switching Centre) of the GSM network would be directly connected to an Internet server via 64 kbps PCM (Pulse Code Modulation).

The manner in which telephone calls are established, via the Internet 3, between the PSTN subscriber telephones 1 and 2 and/or between the Internet user terminal 6 and a PSTN subscriber telephone 1 or 2, is well known to persons skilled in the art and will not, therefore, be addressed, in great detail, by this patent specification.

In order to be able to interconnect speech to an Internet telephony user, via GSM, or conventional PSTN, it is necessary to have a coder which is adapted to re-code the PCM-coded speech data flow and to send this over the Internet. Equipment for effecting this task is readily available from a number of manufacturers. These equipments are, however. primarily based on either PSTN-to-PSTN, or Internet-to-PSTN. These models are easier to solve than a telephone call which originates in the PSTN, or GSM speech service. and terminates in the Internet.

The problem facing the GSM subscriber is how he/she is to address the Internet user without having access to an alphanumeric keyboard. The SMS service of GSM has an alphanumeric capability and can, therefore, be used for GSM/Internet telephony services.

If a B-subscriber (called party, or recipient) is PSTN-connected, the recipient's usual telephone number is specified on calling. Basically, by dialling the B-subscriber's telephone number, the Internet telephony server can connect to the Internet telephony server located nearest the B-subscriber and route the call to that server. The distant server, i.e. local to the B-subscriber, then calls the B-subscriber, and a call connection can be established.

However, if a GSM subscriber (A-subscriber, or calling party) wishes to make telephone contact with a third party (B-subscriber, or called party) who does not have a 'conventional' telephone number, but is connected to the Internet, i.e. is an Internet user, the A-subscriber must specify the recipient's (called party's) 'Web Phone Number'. This may be an Internet, or e-mail, address. It is difficult, if not impossible, to transfer this information from a GSM mobile station/handset, or from a conventional telephone, to the server. An Internet address, i.e. the IP (Internet Protocol) address, which is 12 digits long, can certainly be transferred by DTMF (Dual Tone Multifrequency). However, if the calling party only has the e-mail address, i.e. a DNS (Domain Name System) address, and not the Internet address (IP address), for an Internet user he/she wishes to call, it is difficult, if not impossible, for the calling party to establish a connection to the Internet user. Thus, in these circumstances, it will be necessary for the Internet address to be separately transferred to an Internet telephony server, and possibly also for a personal address list to be established in an Internet telephony server to which the user has a subscription. This can be effected, in accordance with the present invention, by using the GSM short message service (SMS), in a manner which will subsequently be described with reference to Figure 2 of the accompanying drawings.

It will be seen from Figure 2 of the accompanying drawings, which diagrammatically illustrates a communication system according to the present invention, that the Internet user terminal 6/telephone handset 7 combination of Figure 1 of the accompanying drawings, is also shown in Figure 2, together with a GSM mobile station/handset 8, GSM network 9, SMS Service Centre (SC) 10 and Telephony/Internet IWU Server 11 which is connected to the GSM network 9 and the SMS SC 10. The communication system of Figure 2 is adapted to connect a telephone call, originated by the GSM mobile station 8, to a user of the Internet terminal 6 using SMS to facilitate the transfer of the Internet address for the user terminal 6.

Thus, when a GSM subscriber wishes to make an Internet telephone call, using the mobile station 8, to an Internet-connected user, i.e. the user of the Internet user terminal 6, SMS is used to transfer the Internet address information, for the Internet user, to the Internet server 11 via the SMS Service Centre 10. With such an interconnection arrangement, several different scenarios are possible.

A first one of these scenarios, which provides the simplest solution, uses the GSM short message service (SMS) to transfer:

- the Internet address information from the GSM mobile station 8 to the Telephony/Internet IWU (InterWorking Unit) server 11; and

- from the server 11 to the GSM mobile station 8, information for effecting the establishment of a telephony/Internet telephony connection between the GSM mobile station 8 and an Internet user, i.e. information which identifies the server's telephone number and which informs the GSM subscriber that a connection to the Internet user is possible.

On receipt of this information, the GSM mobile station 8 can then connect a telephone call to the server 11, which associates the telephone call with the previously sent Internet address for the Internet user. In operation, the following are sent to the interworking server 11 via SMS:

- the Internet address to the destination computer, i.e. the Internet user terminal 6 of the called party; and

- the specific identity, for example, the specific telephone number for the GSM subscriber - an A-number analysis can be used to obtain the specific identity, which is why it need not be stated in plain language in the SMS message.

The server 11 responds with an SMS - this SMS includes information that a connection to the Internet user (Internet address) is possible, together with the telephone number for the interworking server 11.

The GSM subscriber can then call the server's telephone number and, on receipt of this call, the server 11 can, via an A-number analysis (see above), associate the telephone call to the Internet address previously sent in the first SMS. In practice, the Internet address is associated with the GSM A-telephone number for a specific period of time which is monitored by a timer which forms part of the communication system. The server 11 thereafter connects the telephone call either directly to the Internet user, or indirectly via at least one additional Internet server, a server at the end of this chain being adapted to provide Internet telephony services.

It will be seen, from the foregoing description of the first interconnection scenario, that a method, according to present invention, for enabling a mobile subscriber station of a cellular radio communication network to make an Internet telephone call to an Internet user, is characterised by the steps of:

(a) a user of said mobile subscriber station sending the following information to a telephony/Internet server using SMS:

  - information identifying the Internet address for said Internet user; and

  - the specific identity of said mobile subscriber station (for example, the telephone number for the mobile subscriber station);

(b) said telephony/Internet server, in response to receipt of said information, sending an SMS to said mobile subscriber station, said SMS including the following information:

- that connection to the Internet address is possible; and

- the server's telephone number;

(c) a user of said mobile subscriber station, on receipt of the SMS from the server, calling the server's telephone number; and

(d) the server, on receipt of the telephone call from the mobile subscriber station:

- identifying the calling party (mobile subscriber station) using, for example, A-number analysis;

- associating the telephone call with the Internet address previously received in the SMS from the mobile subscriber station; and

- connecting the telephone call to the Internet address.

The advantages of this interconnection arrangement are that the Telephony/Internet server 11 does not need to know the identity of the GSM subscriber, and no subscription is needed.

If a GSM operator is in possession of appropriate equipment, debiting charges for the telephone can be effected, in a manner know to persons skilled in the art, without any very serious problems.

Another one of the interconnection scenarios, which is a more advanced version of the first interconnection scenario, involves the establishment of an address list in the Internet telephony server 11. In this case, the GSM subscriber will have a subscription with an Internet telephony service provider.

This, more advanced, scenario uses the same SMS, as outlined above for the first scenarios, i.e. with the Internet address being sent to the destination computer and the specific identity to the server 11. The SMS reply contains, in addition to the telephone number to the server and information that call connection is possible, an address listing including the Internet address for the Internet user. Each address list number corresponds to one of the Internet addresses in the GSM subscriber's address list in the server. These numbers can be stored in the mobile subscriber telephone's telephone number list.

In the event that a GSM subscriber forgets a number, the SMS procedure, as outlined above, can be effected in order to obtain the Internet address list number. The subscriber can also request a complete listing of the Internet address list, or search for a specific letter.

It will be seen, from the foregoing description of the second interconnection scenario, that a method, according to present invention, for enabling a mobile subscriber station of a cellular radio communication network to make an Internet telephone call to an Internet user, is characterised by the steps of:

(a) establishing and storing a list of Internet addresses for each mobile subscriber station user wishing to make Internet telephone calls;

(b) assigning, for each address in the Internet address list, a number which uniquely identifies these addresses;

(c) a user of said mobile subscriber station sending the following information to a telephony/Internet server using SMS:

- information identifying the Internet address for said Internet user; and

- the specific identity of said mobile subscriber station (for example, the telephone number for the mobile subscriber station);

(d) said telephony/Internet server, in response to receipt of said information, sending an SMS to said mobile subscriber station, said SMS including the following information:

- that connection to the Internet address is possible;

- the server's telephone number; and

- an address list number for the Internet address, each address list number corresponding to one of the Internet addresses in the mobile subscriber station user's address list in the telephony/Internet server;

(e) a user of said mobile subscriber station, on receipt of the SMS from the server, calling the server's telephone number;

(f) the telephony/Internet server, on receipt of the telephone call from the mobile subscriber station, transmitting a voice message to said mobile subscriber station requesting the user to key in an address list number; and

- when said mobile subscriber station user keys in said address list number, said telephony/Internet server connects the user of said mobile subscriber station to an Internet user at the Internet address corresponding to the address list number; or

- said telephony/Internet server, in the absence of a response from the Internet user, notifying the user of said mobile subscriber terminal by means of either a voice message, or tones, as in conventional telephony, that the Internet user is engaged, or is not replying, or does not have an Internet telephony application.

The advantage of the second interconnection scenario is that:

- the service becomes more user-friendly; and

- a conventional telephone (not having access to an SMS facility) with a DMTF function can be used to call an Internet user if the address list number is known.

In the case of the second, or more advanced scenario, outlined above, if a GSM subscriber has 32 addresses in his/her list and wants to connect a telephone call to a new address, then the following procedure would have to be effected:

(1) The GSM subscriber sends a call connect request, together with an enquiry about the Internet address's address list number in the server 11.

SMS: <internet address> (12 digits, or e-mail address)

(2) The server 11 stores the new address in the address list and sends back, to the GSM subscriber, the address list number, telephone number, and information that coupling is possible.

SMS: coupling to <internet address> is OK! Call
<server telephone number>[pause]<address list number#>
(list number in this case would be 33#, or the first vacant one)

(3) The GSM subscriber can now call the server's telephone number. On receipt of a call from the GSM subscriber, the server transmits a voice message requesting the user (by DMTF) to key in an address list number. On some GSM-compatible mobile stations/telephones, for example, the Ericsson GH388, a DMTF string can be added to the telephone number, after a pause symbol, before the connection is made. A telephone number sent by the server in SMS would then appear as follows: 0705110646p33#.

When the GSM subscriber has dialled the number and the address list number, the server 11 establishes an Internet connection to the destination address (possibly via at least one additional Internet telephony server, as outlined above). If the Internet user does not reply, the GSM subscriber is notified via either a speech message, or tones, as in conventional telephony. A notification message may be that the Internet user:

– is engaged;

– is not replying; or

– does not have an Internet telephony application.

As an alternative to SMS, the GSM service 'Alternate Speech/Data' could be used. The advantages of this alternative are that only one call coupling is required. With this alternative arrangement, the telephone call is initiated through data transfer of the Internet address to the server 11 from the mobile station/handset 8, after which the server 11 can connect the connection to the Internet party. The GSM access then connects over the speech, and the call can take place. The disadvantage of this solution is that data terminal functionality is required, for example, a computer, or advanced GSM mobile terminal, for example, the Nokia Communicator 9000 type. Note that this is not necessary if SMS is used as data carrier.

It will be seen from the foregoing description that the present invention relates to the manner in which a GSM subscriber can connect an Internet telephone call through the IP (Internet Protocol) address information being transferred via SMS and can, therefore, be used for an Internet telephony service based on GSM's speech service access. The use of the short message service (SMS), available in a mobile telephone terminal, to transfer an Internet address, or e-mail address with alphanumeric symbols, means that no additional equipment is required, such as, for example, a portable computer, to transfer Internet telephony calls to an Internet-connected called party.

CLAIMS

1. A communication system adapted to establish connections to, and between, Internet users, characterised in that said communication system includes a cellular radio communication network adapted to provide a short message service (SMS), and a server adapted to facilitate the establishment of a telephony/Internet connection between a mobile subscriber station of said network and an Internet user, and in that said SMS is adapted to transfer:

- from said mobile subscriber station to said server, information identifying the Internet address for said Internet user; and

- from said server to said mobile subscriber station, information relating to said connection between said mobile subscriber station and said Internet user.

2. A communication system as claimed in claim 1, characterised in that said SMS is used to transfer the following information to said telephony/Internet server:

- the Internet address for an Internet-connected computer terminal of said Internet user; and

- a specific identity for said mobile subscriber station.

3. A communication system as claimed in claim 2, characterised in that said specific identity for said mobile subscriber station is a telephone number for said mobile subscriber station.

4. A communication system as claimed in claim 2, or claim 3, characterised in that said telephony/Internet server includes analysing means for effecting, on receipt of said SMS-transferred information, an A-number analysis to determine the A-telephone number identity of said mobile subscriber station.

5. A communication system as claimed in any of claims 2 to 4, characterised in that

said telephony/Internet server is adapted, in response to receipt of said SMS-transferred information from said mobile subscriber station, to send an SMS to said mobile subscriber station including the following information:

– that call connection to said Internet user is possible; and

– the server's telephone number.

6. A communication system as claimed in claim 5, characterised in that said telephony/Internet server is adapted, on receipt of a call from said mobile subscriber station, made using the server's telephone number, to:

– identify said mobile subscriber station (calling party);

– associate the telephone call with the Internet address previously transferred to said server by said mobile subscriber station; and

– connect the telephone call to the Internet address.

7. A communication system as claimed in claim 6, when appended to either claim 4, or claim 5, characterised in that said telephony/Internet server is adapted to identify said mobile subscriber station (calling party) using said A-number analysing means.

8. A communication system as claimed in claim 7, characterised in that said Internet address is associated with the A-telephone number of said mobile subscriber station for a specific period of time which is monitored by a system timer.

9. A communication system as claimed in any of claims 6 to 8, characterised in that said telephony/Internet server is adapted to connect the telephone call directly to the Internet address.

10. A communication system as claimed in any of claims 6 to 8, characterised in that said telephony/Internet server is adapted to connect the telephone call to the Internet

address via at least one additional Internet server, a server at the end of this chain being adapted to provide Internet telephony services.

11. A communication system as claimed in any preceding claim, characterised in that said telephony/Internet server includes means for establishing and storing a list of Internet addresses for each mobile subscriber station user subscribing to the system, and in that each one of said Internet addresses has an address list number.

12. A communication system as claimed in claim 11, characterised in that said telephony/Internet server is adapted, in response to receipt of said SMS-transferred information from said mobile subscriber station, to send an SMS to said mobile subscriber station including the following information:

- that call connection to said Internet user is possible;
- the server's telephone number; and
- an address list number for the Internet address, each address list number corresponding to one of the Internet addresses in the mobile subscriber station user's address list in the telephony/Internet server.

13. A communication system as claimed in claim 12, characterised in that said address list numbers are stored in a respective mobile subscriber station's telephone number list.

14. A communication system as claimed in any of claims 11 to 13, characterised in that a mobile subscriber station is adapted to request from said telephony/Internet server, and said telephony/Internet server is adapted to supply to the mobile subscriber station, a complete listing of the Internet address list.

15. A communication system as claimed in any of claims 11 to 13, characterised in that a mobile subscriber station is adapted to search for a specific one of the Internet addresses stored by said telephony/Internet server.

16. A communication system as claimed in any of claims 11 to 13, characterised in that said telephony/Internet server is adapted, on receipt of a call connection request from a mobile subscriber station to an unlisted Internet address, to:

- store, and assign an address list number to, the unlisted Internet address; and
- send back, to the mobile subscriber station, via SMS, the following information to enable a user of said mobile subscriber station to call said Internet address:
  - the assigned address list number;
  - the server's telephone number; and
  - information that call connection is possible to the Internet address.

17. A communication system as claimed in any one of the preceding claims, characterised in that said cellular radio communication network is a GSM network.

18. A method for enabling a mobile subscriber station of a cellular radio communication network to make an Internet telephone call to an Internet user, characterised by the use of SMS to transfer:

- from said mobile subscriber station to a telephony/Internet server information identifying the Internet address for said Internet user; and
- from said telephony/Internet server to said mobile subscriber station, information relating to said connection between said mobile station and said Internet user.

19. A method as claimed in claim 18, characterised by said SMS being used to transfer the following information to said telephony/Internet server:

- the Internet address for an Internet-connected computer terminal of said Internet user; and

– a specific identity for said mobile subscriber station.

20. A method as claimed in claim 19, characterised in that said specific identity of said mobile subscriber station is a telephone number for said mobile subscriber station.

21. A method as claimed in claim 19, or claim 20, characterised by said telephony/Internet server, on receipt of said SMS-transferred information, using A-number analysis to determine the A-telephone number identity of said mobile subscriber station.

22. A method as claimed in any of claims 19 to 21, characterised by said telephony/Internet server, in response to receipt of said SMS-transferred information from said mobile subscriber station, sending an SMS to said mobile subscriber station including the following information:

– that call connection to said Internet user is possible; and

– the server's telephone number.

23. A method as claimed in claim 22, characterised by:

– said mobile subscriber station calling the server's telephone number; and

– said server, on receipt of the call from said mobile subscriber station:

  – identifying said mobile subscriber station (calling party);

  – associating the telephone call with the Internet address previously transferred to said server by said mobile subscriber station; and

  – connecting the telephone call to the Internet address.

24. A method as claimed in claim 23, when appended to either claim 21, or claim 22,

characterised by said telephony/Internet server identifying said mobile subscriber station (calling party) using said A-number analysis.

25. A method as claimed in claim 24, characterised by associating said Internet address with the A-telephone number of said mobile subscriber station for a specific period of time, and by monitoring said period of time.

26. A method as claimed in any of claims 23 to 25, characterised by said telephony/Internet server connecting the telephone call directly to the Internet address.

27. A method as claimed in any of claims 23 to 25, characterised by said telephony/Internet server connecting the telephone call to the Internet address via at least one additional Internet server, a server at the end of this chain being adapted to provide Internet telephony services.

28. A method as claimed in any of claims 18 to 27, characterised by said telephony/Internet server establishing and storing a list of Internet addresses for each mobile subscriber station user wishing to make Internet telephone calls, and by each one of said Internet addresses having an address list number.

29. A method as claimed in claim 28, characterised by said telephony/Internet server, in response to receipt of said SMS-transferred information from said mobile subscriber station, sending an SMS to said mobile subscriber station including the following information:

- that call connection to said Internet user is possible;
- the server's telephone number; and
- an address list number for the Internet address, each address list number corresponding to one of the Internet addresses in the mobile subscriber station user's address list in the telephony/Internet server.

30. A method as claimed in claim 29, characterised by storing said address list numbers in a respective mobile subscriber station's telephone number list.

31. A method as claimed in any of claims 28 to 30, characterised by a mobile subscriber station requesting a complete listing of the Internet address list from said telephony/Internet server.

32. A method as claimed in any of claims 28 to 30, characterised by a mobile subscriber station searching for a specific one of the Internet addresses stored by said telephony/Internet server.

33. A method as claimed in any of claims 28 to 30, characterised by said telephony/Internet server, on receipt of a call connection request from a mobile subscriber station to an unlisted Internet address:

- storing, and assigning an address list number to, the unlisted Internet address; and

- sending back, to the mobile subscriber station, via SMS, the following information to enable a user of said mobile subscriber station to call said Internet address:

  - the assigned address list number;

  - the server's telephone number; and

  - information that call connection is possible to the Internet address.

34. A method as claimed in any one of claims 18 to 33, characterised in that said cellular radio communication network is a GSM network.

35. A method for enabling a mobile subscriber station of a cellular radio communication network to make an Internet telephone call to an Internet user, characterised by:

- a user of said mobile subscriber station sending the following information to a telephony/Internet server using SMS:

  - information identifying the Internet address for said Internet user; and

  - the specific identity of said mobile subscriber station (for example, the telephone number for the mobile subscriber station);

- said telephony/Internet server, in response to receipt of said information, sending an SMS to said mobile subscriber station, said SMS including the following information:

  - that connection to said Internet address is possible; and

  - the server's telephone number;

- a user of said mobile subscriber station, on receipt of the SMS from the server, calling the server's telephone number; and

- the server, on receipt of the telephone call from the mobile subscriber station:

  - identifying the calling party (mobile subscriber station) using, for example, A-number analysis; and

  - associating the telephone call with the Internet address previously received in the SMS from the mobile subscriber station; and

  - connecting the telephone call to the Internet address.

36. A method for enabling a mobile subscriber station of a cellular radio communication network to make an Internet telephone call to an Internet user, characterised by:

- establishing and storing a list of Internet addresses for each mobile subscriber station user wishing to make Internet telephone calls;

- assigning, for each address in the Internet address list, a number which uniquely identifies these addresses;

- a user of said mobile subscriber station sending the following information to a telephony/Internet server using SMS:

    - information identifying the Internet address for said Internet user; and

    - the specific identity of said mobile subscriber station (for example, the telephone number for the mobile subscriber station);

- said telephony/Internet server, in response to receipt of said information, sending an SMS to said mobile subscriber station, said SMS including the following information:

    - that connection to said Internet address is possible;

    - the server's telephone number; and

    - an address list number for the Internet address, each address list number corresponding to one of the Internet addresses in the mobile subscriber station user's address list in the telephony/Internet server;

- a user of said mobile subscriber station, on receipt of the SMS from the server, calling the server's telephone number;

- the telephony/Internet server, on receipt of the telephone call from the mobile subscriber station, transmitting a voice message to said mobile subscriber station requesting the user to key in an address list number; and

- when said mobile subscriber station user keys in said address list number, said telephony/Internet server connecting the user of said mobile subscriber station to an Internet user at the Internet address corresponding to the address list number.

37. A method as claimed in claim 36, characterised by said telephony/Internet server, in the absence of a response from the Internet user, notifying the user of said mobile subscriber terminal by means of either a voice message, or tones, as in conventional telephony.

38. A method as claimed in claim 37, characterised by said notification being that the Internet user is engaged, or is not replying, or does not have an Internet telephony application.

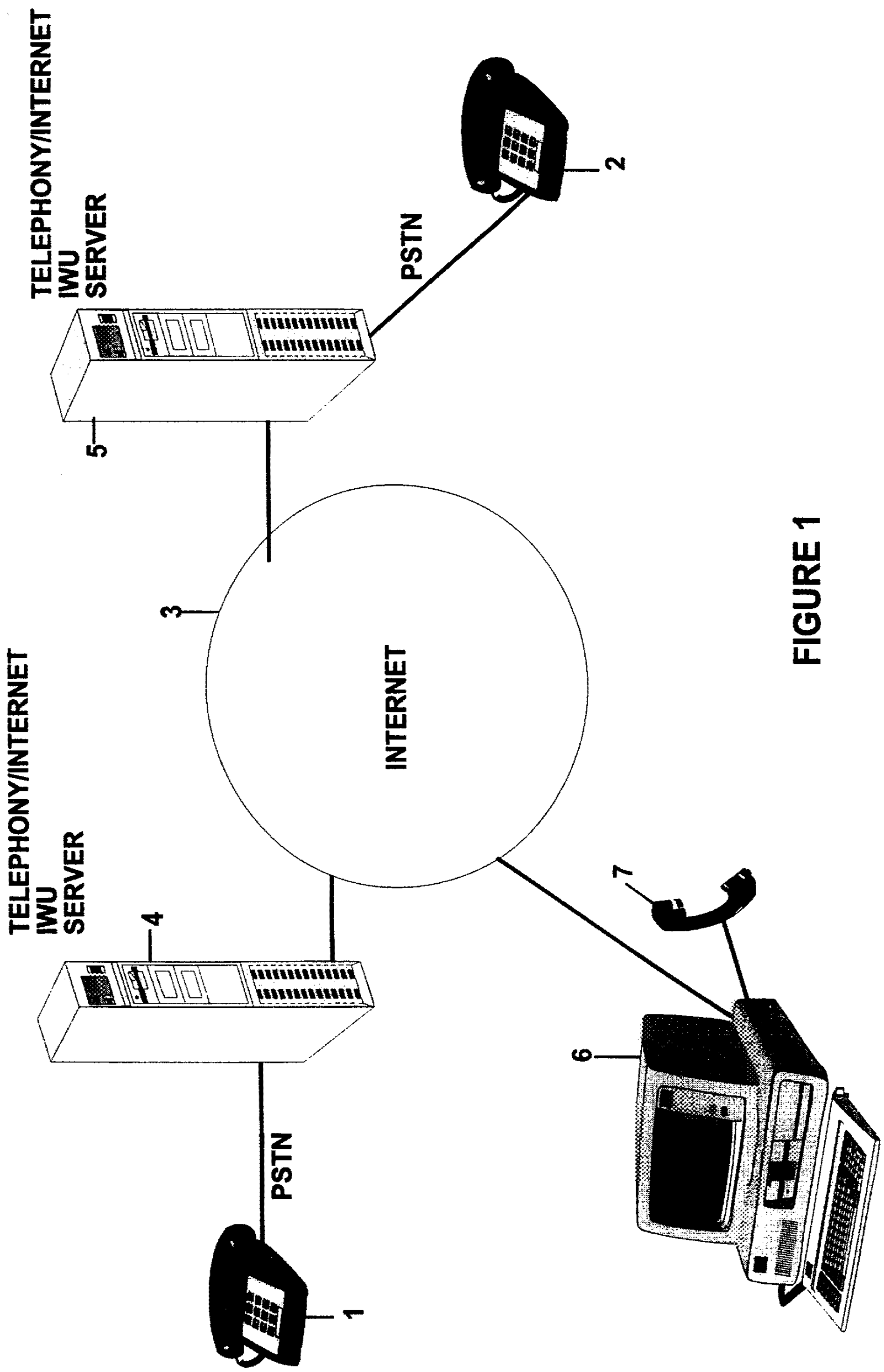
TELEPHONY/INTERNET
IWU
SERVER
5
PSTN
2
3
INTERNET
TELEPHONY/INTERNET
IWU
SERVER
4
PSTN
1
6
7

FIGURE 1

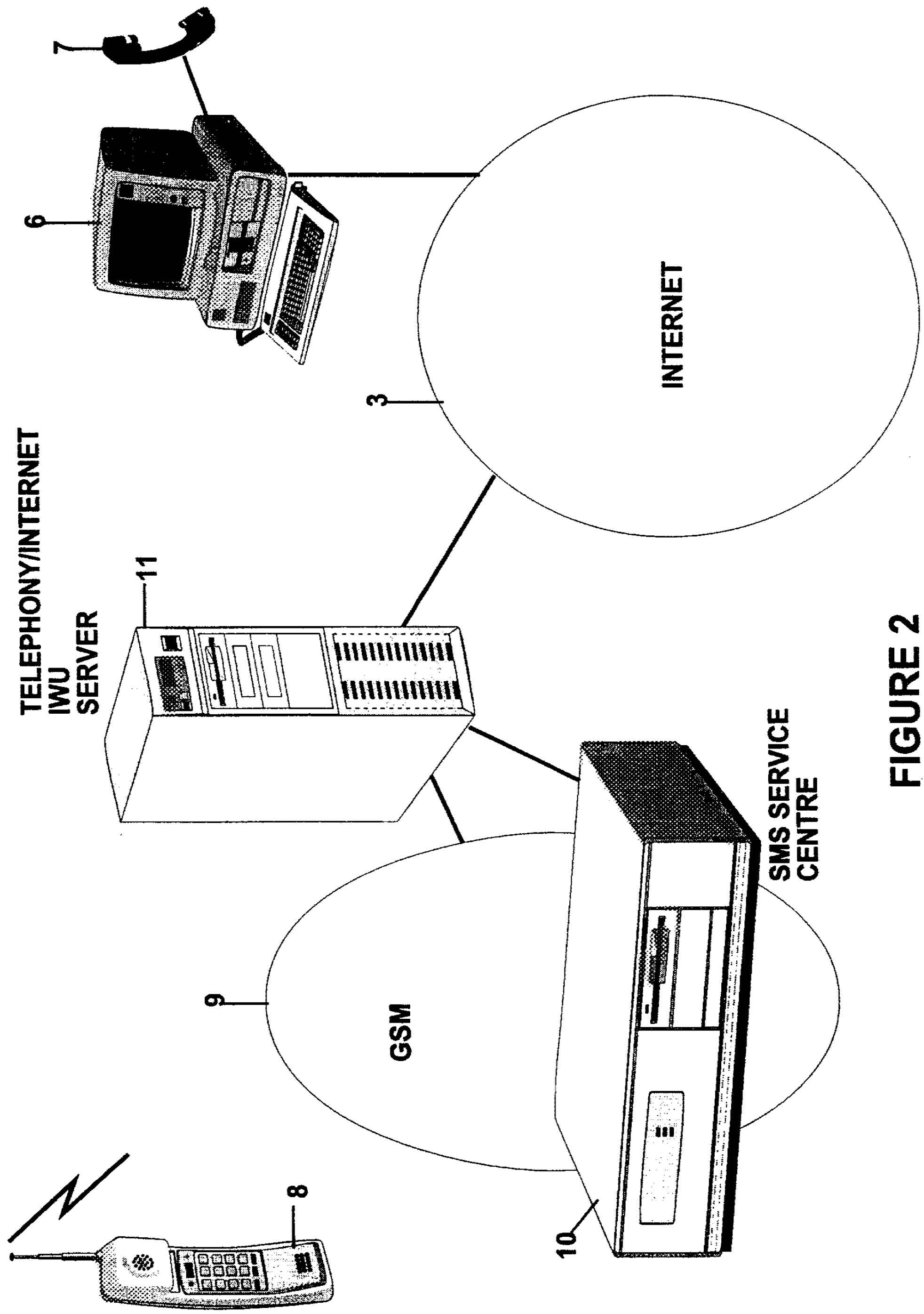
7
6
TELEPHONY/INTERNET
IWU
SERVER
11
3
INTERNET
9
GSM
SMS SERVICE
CENTRE
8
10

FIGURE 2

# INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/01349

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/22, H04L 29/06, H04M 7/12 // H04M 3/50
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| P,X | EP 0795991 A1 (HEWLETT-PACKARD COMPANY), 17 Sept 1997 (17.09.97), see the whole document<br>-- | 1,18,35,36 |
| A | WO 9731498 A2 (TELECOM FINLAND OY), 28 August 1997 (28.08.97), abstract, see the whole document<br>-- | 1-38 |
| A | WO 9713382 A1 (NORTHERN TELECOM LIMITED), 10 April 1997 (10.04.97), page 2, line 21 - page 5, line 2, abstract<br>-- | 1-38 |
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☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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## INTERNATIONAL SEARCH REPORT
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(71) Applicant: INFOGEAR TECHNOLOGY CORPORATION [US/US]; Suite 200, 2055 Woodside Road, Redwood City, CA 94061 (US).

(72) Inventors: BENDELAC, Chaim; Yekutiel Adam Street 1b, 44282 Kfar–Saba (IL). BITTMAN, Ran, M.; Hakneset Hagdola Street 20, 62917 Tel Aviv (IL). SAMBURSKI, Kobi; Ig'al Alon Street 30b, 46324 Herzliya (IL).

(74) Agents: GLENN, Michael, A. et al.; Law Offices of Michael A. Glenn, P.O. Box 7831, Menlo Park, CA 94026 (US).

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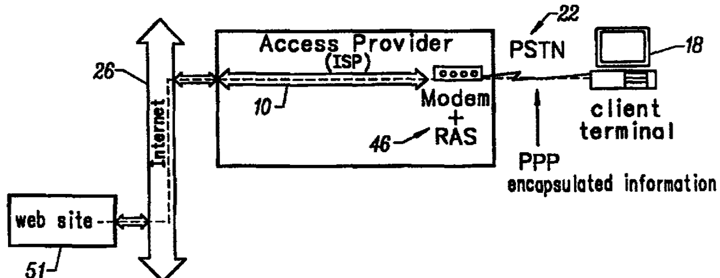
(54) Title: METHOD AND SYSTEM FOR NETWORK ACCESS OVER A LOW BANDWIDTH LINK




Traditional Internet Connection

(57) Abstract

A method and system are provided for transmitting information from a faster network to a data terminal via a slower network connection. The invention is adapted for use with any Internet access device or terminal, such as an Internet–compatible telephone. A client connects to the Internet via an intermediary software program, known as the Gateway (GW). In the preferred embodiment of the invention, the GW executes on a host computer of an ISP's Local Area Network (LAN). The GW thus mediates the data transfer between the Internet, such as the Web, and the client Internet terminal. The GW employs a point–to–point Internet protocol, the Gateway Interface Protocol (GWIP) to communicate with the client over the low–bandwidth link. The invention shifts the entire overhead of the Internet protocol stack to the GW, and does not involve the Internet terminal or the slow link between Internet terminal and GW. The GW makes and negotiates multiple Internet requests, in parallel, and multiplexes the resulting data streams, allowing documents to be loaded in parallel with their associated images. The GW may also be used to conveniently customize or upgrade the Internet terminal. The GW performs off–line services and caches commonly used information fetched from the Internet. The invention is also readily adapted for use with Internet access devices that require different document formats.

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# METHOD AND SYSTEM FOR NETWORK ACCESS OVER A LOW BANDWIDTH LINK

## BACKGROUND OF THE INVENTION

### TECHNICAL FIELD

The invention relates to data communication networks. More particularly, the invention relates to transmitting information from a faster network to a data terminal via a slow network connection.

### DESCRIPTION OF THE PRIOR ART

Electronic commercial and academic computer networks have been in existence for many years. An example of a commercial network is America On-Line. The largest and best-known electronic network is commonly known as the Internet. The Internet is a world-wide "network of networks" that is composed of thousands of interconnected computers and computer networks.

The preferred protocol of communications on the Internet is a set of standards and protocols, commonly referred to as TCP/IP. These TCP/IP protocols provide the means to establish a connection between two nodes on the network, and to subsequently transfer messages and data between these nodes. TCP (Transmission Control Protocol) provides the logical connection to ensure delivery of an entire message or file, while IP (Internet Protocol) provides the routing mechanism.

The majority of residential and commercial users of such computer networks (the clients) do not have a direct connection to the network. They subscribe to the services of an access provider, commonly called "Internet Service Provider" (ISP) in the case of the Internet. Clients use a personal computer or other terminal that is equipped with a data modem, to dial into the ISP connection service.

Fig. 1 is a diagram of the topology of an Internet connection via an ISP, according to the prior art. The ISP maintains a network 10 that connects its clients to the Internet 26. This network includes the ISP backbone 12, which is an internal set of connected nodes. ISP backbones are typically connected to points of presence, known as POPs 14, and management (control) centers 16. The POP is typically the local exchange that users dial into via modem. There are usually few management centers and many POPs in an ISP backbone.

The ISP typically connects to the Internet via a Local Area Network (LAN) 28 at the management center. However, the ISP host may also be connected to the Internet via a Wide Area Network (WAN) such as the X.25 style Public Data Network (PDN). The LAN communicates with the Internet 26 through a physical, wide-bandwidth connection 30. However, the client does not connect to the LAN through such wide-bandwidth connection. Rather, the client accesses the Internet by using a computer 18 with a modem 20 to dial up, through the public telephone system 22, another modem in a local POP 24. This modem-to-modem connection is a relatively slow, low bandwidth two-directional link.

The ISP usually provides a relatively slow point-to-point (serial) two-dimensional link, through which the client communicates directly to the Internet, using the Internet standard TCP/IP protocols. Such serial link transfers digital data one bit after the other. The Recommended Standard-232 (RS-232) is the standard commonly followed for serial data transmission. (See, for example, *Electronic Industries Association*, EIA Standard RS-232-C, "Interface Between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange", August 1969.)

Point-to-point links are among the oldest methods of data communications and almost every host supports point-to-point connections. A long-distance point-to-point link is achieved by using a modem to establish a dial-up link between a display terminal, such as a personal computer, and the other host, such as a host located on the ISP site.

The communication over the serial point-to-point line is in the form of encapsulated (framed) TCP/IP datagrams (data packets) using either Serial Line Internet Protocol (SLIP) or Point-to-Point protocol (PPP) packet framing.

The SLIP protocol is described in *IETF Network Working Group (J. Romkey)*, "A NONSTANDARD FOR TRANSMISSION OF IP DATAGRAMS OVER SERIAL LINES: SLIP ," Request for Comments: 1055 - June 1988. The PPP protocol is described in *IETF Network Working Group (D. Perkins),* "The Point-to-Point Protocol for the Transmission of Multi-Protocol Datagrams Over Point-to-Point Links," Request for Comments: 1171. SLIP transmits IP data packets over any serial link, such as a telephone line. It is generally used to provide Internet access to networks that support TCP/IP. PPP is a more common data link protocol that provides dial-up access over serial lines.

Fig. 2 is a diagram of a traditional Internet connection according to the prior art. To communicate on the Internet 26, an appliance or terminal (the client) 18 establishes a logical connection with a content provider. This connection is typically made using dial-up equipment, such as a modem 46 to connect to the public telephone system 22. The information transmitted over the telephone line is composed of PPP-wrapped TCP/IP data packets. Essentially, the ISP 10 is a transparent channel through which the client directly communicates with content providers, such as Web sites 51.

There are several disadvantages to this prior art approach. One major disadvantage is that of cost and complexity. Each terminal must be equipped with the ability to handle TCP/IP and PPP or SLIP protocols. This can require as much as 90 Kbytes of code and 70 Kbytes of data. Another major disadvantage is that of bandwidth. The Internet protocol overhead must be transmitted through the slow serial link, thereby reducing the actual useful bandwidth.

Yet another disadvantage is the need to duplicate, in each terminal, the code to deal with every possible type of data that may be transferred. Additionally, the established connection between the client and the Web server is recreated for every required file. This prevents a more general solution where commonly fetched files or messages are cached.

The World-Wide Web (Web) is an Internet client-server distributed information retrieval system. On the Web documents, menus, and indices are represented to the user as hypertext objects. Hypertext is a collection of documents containing cross-references or "links". These links enable the user, with the aid of an interactive browser program, to move from one document to another.

The Web may be accessed through other types of devices than a computer, including personal data assistants, fax machines, and Internet-capable telephones. One device that can provide Internet access is the terminal described in M. Valentaten, B. Moeschen, Y. Friedman, Y.-T. Sidi, Z. Blkowsky, Z. Peleg , *Multi-Mode Home Terminal System that Utilizes a Single Embedded General Purpose/DSP Processor and a Single Random Access Memory*, U.S. Patent No. 5,259,940 (October 5, 1993).

An internet access device, such as a modem-connected personal computer, generally uses a software application known as a Web browser to access the Web information available on the Internet. Such Web browsers, including Navigator, manufactured by Netscape Communications Corporation of Mountain View, California, and Mosaic, owned by the National Center for Supercomputing Applications (NCSA) at the University of Illinois, Urbana-Champaign, use a direct connection to the Web over SLIP/PPP. Thus, all of the overhead, in particular the parallel protocol overhead, is over the slow link.

To mitigate the above-mentioned disadvantages, prior art solutions that do not require the display terminal to handle the TCP/IP protocol set have been used to access the Internet. One such solution is for the user to acquire a shell account on the ISP host computer. With a shell account, a simple text transfer protocol and a terminal-emulator program are used to permit the user to communicate with the Internet through the display terminal, using a text-only Web browser program. One such text-only Web browser is Lynx, developed by the University of Kansas and currently maintained by Foteos Macrides at the Worcester Foundation for Biological Research. However, the shell account approach is subject to the major disadvantage that only plain-text information, and not images, colors, and sounds can be viewed.

Another prior art approach is that of the commercial Internet Web browser SlipKnot, developed by MicroMind, Inc. SlipKnot permits Web browsing through a serial link to a server, typically a Unix server, using a simple dial-in program. A TCP/IP stack is not required. When a user selects a hyperlink using SlipKnot, a textual description of the hyperlink is transferred to the ISP. SlipKnot uses the capabilities of the shell account to execute an "agent" program (such as Lynx) on the ISP machine. This agent fetches the requested multimedia file and uses a data-transfer program, such as xmodem, to transfer the file to the display terminal for display.

However, SlipKnot can be inconvenient to use and install. Furthermore, because the agent program is invoked separately for each separate request, information transfer is inefficient and slow. The SlipKnot method can handle only one request at a time and allows only local caching on the client.

It would therefore be an advantage to provide a method and system that improves the transfer of information from a faster network to a data terminal via a low-bandwidth link. It would be a further advantage if such method and system filters irrelevant Internet information prior to its transfer over the low-bandwidth link. It would be yet another advantage if such method and system reduces, if not entirely eliminates, protocol negotiation over the low-bandwidth link.

## SUMMARY OF THE INVENTION

The invention provides a method and system for transmitting information from a faster network to a data terminal via a slower network connection. The preferred embodiment of the invention is adapted for use with any Internet terminal or access device, such as a telephone. A client connects to the Internet via an intermediary software program, known as the Gateway (GW). In the preferred embodiment of the invention, the GW executes on a host computer of an ISP's Local Area Network (LAN.

The client dials up a Remote Access Server located at the ISP's local point-of-presence. The Remote Access Server communicates, via the ISP's backbone and using the TCP/IP network, with an authentication server. Initial authentication on the incoming calls is performed and the logical connection to the GW is established. The GW, in turn, uses the ISP's communication network and the TCP/IP protocol to connect to the Internet.

The GW thus mediates the data transfer between the Internet, such as the Web, and the client Internet terminal. The GW employs a point-to-point Internet protocol, the Gateway Interface Protocol (GWIP) to communicate with the client over the low-bandwidth link. The invention shifts the entire overhead of the Internet protocol stack to the GW, and does not involve the Internet terminal or the slow link between Internet terminal and GW. The Internet terminal needs no IP address. A single IP address is used by the GW to represent all Internet terminals.

The GW makes and negotiates multiple Internet requests, in parallel, for information to be fetched and loaded from the Internet using the GWIP protocol. The GW parses all requests and forwards them to the appropriate Internet server for execution. The GW filters each received file according to file type, and multiplexes the resulting data streams efficiently over the single link to the Internet terminal, based on the current priority of each stream. This allows documents to be loaded in parallel with their associated images, resulting in a much improved perceived speed. These streams can be paused and resumed as desired, according to a predetermined or dynamic priority. Such parallel retrieval of multiple objects is performed over the slow link without the use and overhead of Internet protocols.

The GW may also be used to conveniently customize the Internet terminal. In one embodiment of the invention, a profile of the Internet terminal user is stored in the Internet terminal. The GW uses this profile to provide customized services, such as sending only thumbnail views of images, or not sending certain material. In another embodiment of the invention, the GW serves as a software upgrade server. Using the GWIP protocol, a new firmware version can easily be uploaded, or a specialized device driver such as a printer driver uploaded as necessary. The invention may be used to upgrade or modify the graphical user interface of the Internet terminal.

In an alternative embodiment of the invention, the GW performs off-line services, such as collecting e-mail, or conducting intelligent off-line searches. The GW can be used to cache commonly used information fetched from the Internet. In one embodiment of the invention, the GW is used as a mechanism for ISPs to track and bill customers for the use of the internet connection.

The invention is also readily adapted for use with Internet access devices that require different document formats and have different display capabilities, such as an Internet-compatible telephone, computer, a cellular phone, or a personal digital assistant having a wireless phone. In the preferred embodiment of the invention, the HTML layout is converted to a compressed equivalent of the HTML layout. Alternative embodiments of the invention do not convert the HTML layout, or convert the HTML to different screen formats.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram of the topology of an Internet connection via an ISP according to the prior art;

Fig. 2 is a diagram of a traditional Internet connection according to the prior art;

Fig. 3 is a diagram of the GW architecture according to the invention;

Fig. 4 is a diagram of the topology of an Internet connection via an ISP according to the invention;

Fig. 5 is a diagram showing the topology of an Internet terminal connection to the Internet according to the invention; and

Fig. 6 is a flow chart of the filtering process according to the invention.

## DETAILED DESCRIPTION OF THE INVENTION

The invention provides a method and system for transmitting information from a faster network to a data terminal via a slower network connection.

The preferred embodiment of the invention is adapted for use with the Web technique described above. However, alternative embodiments of the invention are adapted for use with any Internet access device. Thus, the following discussion is provided for purposes of example and not as a limitation on the scope of the invention.

The Web is usually accessed via telephone lines by a modem-connected computer, or Internet access terminal. The client dials up an ISP, for example using the PPP protocol. In turn, the ISP host establishes the connection to the Internet.

In the invention, however, the client connects to the Internet via an intermediary software program, known as the Gateway (GW). The GW mediates the data transfer between the Internet, such as the Web, and the client computer/Internet access terminal. The GW employs a point-to-point Internet protocol, the Gateway Interface Protocol (GWIP) to communicate with the client over the low-bandwidth link. The invention thereby shifts the entire overhead of the Internet protocol stack to the GW, and does not involve the Internet terminal or the slow link between Internet terminal and GW.

Fig. 3 is a diagram of the GW architecture according to the invention. The invention framework includes a GW 42 that functions as an intermediary between client devices 30, such as an Internet-compatible telephone, and content providers, such as Web sites 51. Therefore, the GW, integrated into the ISP network, mediates access to the Internet on behalf of its clients.

Fig. 4 is a diagram of the topology of an Internet connection via an ISP according to the preferred embodiment of the invention. In the invention, the Internet terminal 30 uses the public telephone system 22 to dial up a local POP 24 within the ISP backbone 12. The GW, which is integrated into the ISPs network 10, mediates access to the Internet on behalf of its clients. The GW is a seamless software addition to standard ISP network configurations.

The ISP's E-mail servers 32, authentication servers 34, network management control 36, and proxy servers 38 are typically located at a management center 16. In the preferred embodiment of the invention, the GW 42 is also located at the management center. The GW preferably executes on a host computer of the ISP's Local Area Network (LAN) 40 with other computers and servers, such as the E-mail servers, network management servers, and authentication servers. However, the GW may also be executed by a dedicated server mediating between the LAN and the client.

The client uses the Internet terminal 30 to dial and connect to a dial-up Remote Access Server 46 which is located at the ISP's local POP 24. This Remote Access Terminal Server communicates, via the ISP's backbone 12 and using the TCP/IP network 44, with an authentication server 34. Initial authentication on the incoming calls is performed and the logical connection to the GW is established. The GW, in turn, uses a router 48 to connect to the Internet 26.

Fig. 5 is a diagram showing the topology of an Internet terminal connection to the Internet according to the invention. The Internet terminal 30 uses a modem 50 to dial-up a modem 52 at the ISP's local POP. This modem can be a hardware device that is located internal or external to the Internet terminal, or can be an integrated software modem. This modem 52 transmits information from the client to the GW 42 on the LAN. The GW uses Hypertext Transfer Protocol (HTTP) and TCP/IP protocol 60 to communicate, via a datalink 54 to the Internet 26. The Internet terminal displays the information retrieved from the Internet on its display screen 56 using a browser application 58.

The GW executes on a host computer with a physical, wide-bandwidth connection to the Internet. However, the client computer does not have such a wide-bandwidth connection to the Internet. Rather, the client computer must connect to the Internet through a low-bandwidth slow link.

The GW employs an extremely simple point-to-point Internet protocol, referred to hereafter as the Gateway Interface Protocol (GWIP) to communicate with the Internet terminal over this relatively slow, low-bandwidth link. The GW then negotiates Internet requests on behalf of the Internet terminal over the fast, wide-bandwidth link. The function of the GW is, therefore, to serve as an agent or representative of the Internet terminal, and to negotiate Internet access on its behalf. As a result, the entire overhead of the Internet protocol stack is handled by the GW, and does not involve the Internet terminal or the slow link between Internet terminal and GW.

A request is a signal sent from a transmitting station to a receiving station requesting permission to transmit information. This permission is given with a response. The GW examines, pre-processes and modifies (filters) the Internet terminal's Internet requests and responses to improve performance and utility. The invention is particularly useful in the context of Internet display terminals, such as the Internet-compatible telephone, having a low bandwidth connection and limited storage capabilities.

A Web page is encoded in Hypertext Markup Language (HTML). An HTML document is a plain-text (ASCII) file that uses tags to denote the various elements in the document. An element may include an attribute, which is additional information that is included between tags.

HTML can be used to link text and/or images, such as icons, to another document or section of a document. The user activates a link by clicking on it, and the linked database is directly accessed. Links are used to access related information, or to contact a person or entity. However, information on a Web page must have the requisite HTML tags to be an active link.

In the invention, the client selects a hyperlink request for a text or image file on the Web. The Internet terminal forwards the request to the GW using the GWIP protocol. If the page in question contains embedded images, the Internet terminal forwards additional, parallel requests for the images as well.

The GW simplifies the transmission of requested Internet data, as compared to the prior art. Because the GW handles the protocol negotiation with the Internet data server, it does not need to be negotiated over the slow link. The design of the Internet terminal may therefore be simplified and the amount of traffic over the slow link reduced. Experimental data has shown that the GW is approximately 20% more efficient than a prior art TCP/IP stack connection over PPP.

In the preferred embodiment of the invention, the GW also pre-processes, filters and simplifies the actual data by reducing the amount information that is irrelevant to the display environment that has been identified by the GW. This information can be reduced by such methods as stripping out information, optimizing, compressing, and by generally reducing size. Fig. 6 is a flowchart of the filtering process according to the invention. The client initiates a request to the GW for information from the Internet (100). The GW either identifies (105) or is pre-programmed with a client's attributes.

The GW then negotiates the request with the Internet (110) and retrieves the requested information (115). The GW filters the Internet information by reducing the amount of information that is not relevant to the client's attributes (120). The GW then sends to the client only that information which is needed (120). Therefore, bandwidth is not wasted on irrelevant or useless information and the client's processor does not have to process the unnecessary information. The size or power of the Internet terminal processor can therefore be reduced as compared to the prior art, resulting in cost and maintenance savings to the client.

For example, extra (redundant) color information is removed from images, or is reduced according to the physical characteristics of the display. Thus, if the receiving internet access terminal has a gray scale display, there is no need to transmit the color-related information over the slow link.

The GW reduces the amount of this irrelevant information in the HTML coding of a Web page before the page is transmitted over the low bandwidth link to the client. Data pages can also be stripped of redundant blank characters, or converted to a more efficiently compressed equivalent data format. This results in improved usage of the bandwidth of the slow link. Experimental data has shown that by pre-processing, filtering, and simplifying the actual data, the GW is approximately 10% more efficient than the prior art.

The invention uses a low-power compression/ decompression scheme, such as run-length encoding (RLE). This data compression scheme converts a "run" of identical characters into a code. Using this two-dimensional run-length compression, the GW compresses data on the fly without a lot of complex looking-back or looking-ahead. Such two-dimensional run-length compression looks in both vertical and horizontal directions at any given coordinate.

The GW makes and negotiates multiple Internet requests, in parallel, for information to be fetched and loaded from the Internet using the GWIP protocol. The GW parses all requests and forwards them to the appropriate Internet server for execution. The GW filters each received file according to file type, and multiplexes the resulting data streams efficiently over the single link to the Internet terminal, based on the current priority of each stream. This allows documents to be loaded in parallel with their associated images, resulting in a much improved perceived speed. These streams can be paused and resumed as desired. Such parallel retrieval of multiple objects is performed over the slow link without the use and overhead of Internet protocols.

The GW may also be used to conveniently customize the Internet terminal. In one embodiment of the invention, a profile of the Internet terminal user is stored in the Internet terminal. The GW uses this profile to provide customized services, such as sending only thumbnail views of images, or not sending certain material. In another embodiment of the invention, the GW serves as a software upgrade server. Using the GWIP protocol, a new firmware version can easily be uploaded , or a specialized device driver such as a printer driver uploaded as necessary.

Furthermore, the GW may be used with the integrated graphical user interface and slide-up window described in *Method And Apparatus For Organizing And Displaying Internet And Telephone Information* , also assigned to InfoGear Technology Corp. of Redwood City, CA, filed in the U.S. Patent and Trademark Office herewith and incorporated as a part hereof. The invention may be used to upgrade or modify the integrated GUI as described in the abovementioned application.

In an alternative embodiment of the invention, the GW is used as an off-line agent. Thus, in situations where the Internet terminal is connected via a link which is not always available, as with dial-up phone lines, the GW performs off-line services, such as collecting e-mail, or conducting intelligent off-line searches.

The GW can be used to cache commonly used information. A GW that serves multiple Internet terminals can cache the information fetched from the Internet. This reduces overall network access and improves responsiveness. For example, the GW can maintain a local name-to-IP address table.

In one embodiment of the invention, the GW is used as a mechanism for ISPs to track and bill customers for the use of the internet connection. For example, the GW can keep track of charges that the user accepts for the privilege of accessing certain copyrighted material.

The GWIP protocol is a high-level (session layer), full duplex, point-to-point data transfer protocol. It is used between a single client, such as the Internet-compatible telephone, and a single server running the GW. The entire GWIP protocol may be encapsulated by lower-level network transport protocols, such as V42/V42.bis, X.25, or even PPP/TCP/IP. These encapsulating protocols may add compression, encryption and reliability, as required.

GWIP assumes that the underlying transport is error free. It is optimized to allow efficient asynchronous data transfer over a serial sequential medium, such as a relatively slow serial modem line.

The GWIP protocol consists of small data packets, typically about 250 bytes, which provide the capability for multiple interleaved data streams in both directions. There is no concept of "embedded," "escaped," or "out-of-band" control characters; all control information is in the form of complete GWIP packets. The GWIP described below is optimized for use with an Internet-compatible telephone. However, one skilled in the art will readily appreciate that the GWIP may be adapted to other Internet terminals, including different types of Internet-compatible telephones.

Table 1 describes the GWIP protocol structure. All GWIP packets start with a DLE character, followed by a byte, designated "len," with the length of the rest of the packet. The DLE character is a non-printable character that is used to indicate a beginning of a message. This convention provides a small measure of error-detecting redundancy over a normally error-free transport layer.

| | | | |
|---|---|---|---|
| DLE | *len* | *t* | *data* |

**TABLE 1**

The third byte of a GWIP packet ("*t* " in Table 1, above) always indicates the packet type. Additional data fields are optional. The packet type determines the packet destination and structure. Multiple-byte integer values are transmitted in network byte order (MOST significant byte first).

In most cases, the Internet terminal issues a request (a GWIP command), to which the GW responds by issuing one or more GWIP response packets. A request is always associated with a new stream. A stream comprises multiple packets that are logically associated via a common stream handle. A handle is an unsigned integer between 0 and 254 (255 is reserved). Responses use the same handle as the original request. Streams are sometimes also known as virtual channels. The GW may also issue spontaneous status and service messages that are related to one of the open streams.

A connection between the Internet terminal and the GW host (server) is always initiated by the client. As soon as a data connection is established, a configuration dependent exchange takes place between the Internet terminal and the GW host. This results in the establishment of a logical link between the Internet terminal and the GW software.

At this point, the GW waits for a special sequence of four bytes, that indicates the version of the GWIP protocol supported by the Internet terminal. The structure of this sequence is shown in Table 2, as follows:

| | | | |
|---|---|---|---|
| DLE | *major* | minor | ETX |

**TABLE 2**

The first byte of the sequence is the DLE character and the second byte is a (positive) major version number. The third byte is the minor version number, and the fourth byte the ETX character. ETX is a non-printable character that is frequently used to indicate the end of a message.

The discussion in this application describes an exemplary version of the GWIP protocol specification. One skilled in the art will readily recognize that other versions of the GWIP may be implemented in the invention. Thus, the following discussion is provided for purposes of example and not as a limitation on the scope of the invention.

The GW ignores all bytes that precede this version sequence. When it receives a valid version sequence, it returns a STAT_OK GW_STATUS packet (see below) to the Internet terminal and prepares to handle a regular GWIP session. The Internet terminal repeats the version sequence at, for example, 5-second intervals, until it receives the GW_STATUS packet. The Internet terminal disconnects if no valid response is received after three attempts. This disconnection resets the GW.

Unless specified differently, the word "command" indicates a packet that originates from the Internet terminal terminal; the word "response" refers to a GW initiated packet. types. Most GWIP packet types are used both as commands and response, but may have different formats.

Some commands, such as GW_LOGIN, GW_CONFIG and GW_ANCHOR, have additional command fields. Table 3 shows the GW_LOGIN command. Command fields are pairs of the field "name" (a one byte enumerator), followed by the field "value." Each command field is preceded by a one-byte length field, indicating the total length of the command field.

| | | | |
|---|---|---|---|
| DLE | *len* | type | authentication fields |

**TABLE 3**

Every GWIP session starts with a GW_LOGIN Internet terminal command. This authenticates the Internet terminal. The authentication includes the fields listed in Table 4:

| field | na`me | value length (bytes) |
|---|---|---|
| Internet terminal serial ID (unique) | LOG_SERID | 4 |
| boot-section/Internet terminal version id | LOG_BOOTVER | 4 |
| firmware version id | LOG_FIRMVER | 4 |
| user name (id) | LOG_USER | string |
| password | LOG_PASSWD | string |
| Ö. . | | |

**TABLE 4**

The GW replies with a GW_STATUS response message, with a status STAT_OK, followed by an optional GW_SERVICE message. Any other response, or no response at all, causes the Internet terminal to disconnect.

The only valid commands after GW_LOGIN are GW_CONFIG, GW_LOGOUT, and GW_UPGRADE. The GW_LOGOUT command packet is shown in Table 5.

| | | |
|---|---|---|
| DLE | *len* | type |

**TABLE 5**

The proper way for an Internet terminal to terminate a session is to send a GW_LOGOUT command, and then to wait for the GW_LOGOUT response. A session may also end as a result of the Internet terminal disconnecting deliberately, or as a result of a communication fault or other error.

The GW_LOGOUT response to the Internet terminal GW_LOGOUT command is shown in Table 6. The log out message is optional. After receiving the GW_LOGOUT response, the Internet terminal disconnects from the line.

| | | | |
|---|---|---|---|
| DLE | *len* | type | logout msg |

**TABLE 6**

A GW_CONFIG command is sent by the Internet terminal to the GW immediately after the GW_LOGIN command. The GW_CONFIG command may be repeated at any time after the GW_LOGIN command. GW_CONFIG informs the GW about the user's preference/configuration table, including the language in which service messages must be sent, image preference options, and time out values. All values must be valid. The GW_CONFIG command is shown in Table 7.

| | | | | |
|---|---|---|---|---|
| DLE | *len* | type | PI_type | configuration fields |

**TABLE 7**

The one-byte PI_type field determines the plug-in or GW sub-system that is concerned with these configuration values. Typically, the Internet terminal will send a number of GW_CONFIG commands, one for each type of sub-system or plug-in, whenever the configuration on the Internet terminal is changed by the user. Accepted values for this field include PI_EMAIL, PI_WEB and PI_GEN. The configuration fields listed in Table 8 are defined:

| field | name | value length(bytes) | used by |
|---|---|---|---|
| font size | CONFIG_FONT | 1 | PI_GEN |
| image display method | CONFIG_IMG | 1 | PI_WEB |
| max image size to receive | CONFIG_MAX_IMG_SIZE | 2 | PI_WEB |
| cache refresh options | CONFIG_CACHE | 4 | PI_GEN |
| time out preference | CONFIG_TIMEOUT | 4 | PI_GEN |
| language | CONFIG_LANG | 1 | PI_GEN |
| date& time style | CONFIG_DATE | 1 | PI_GEN |
| email user id | CONFIG_EUSER | string | PI_EMAI L |
| email password | CONFIG_EPASSWD | string | PI_EMAI L |
| Ö. | | | |

**TABLE 8**

The GW responds with a GW_CONFIG response to confirm receipt of the GW_CONFIG command. The Internet terminal does not issue any other type of commands before it receives the GW_CONFIG response. The GW_CONFIG command is thus a synchronization point between the Internet terminal and the GW.

A GW_ANCHOR command is an Internet terminal request for a new hypertext/image file. In an HTML document, the anchor is the format codes that are used to define a link to another page. The handle (*h* ) field identifies the data stream and relates the request with subsequent GW response packets. The 2-byte "width" field indicates the width of the pane, in pixels, in which the information will be displayed. This command packet is followed by one or more GW_DATA packets that include the anchor Uniform Resource Locator (URL), and is terminated by a GW_EOF packet. The GW responds with a GW_ANCHOR response, followed by GW_DATA packets, terminated by GW_EOF. The GW_ANCHOR command is given in Table 9.

| | | | | |
|---|---|---|---|---|
| DLE | *len* | type | h | width |

**TABLE 9**

A GW_REFRESH command is an Internet terminal request for the re-transmission of a hypertext/image document that is partially or fully in the Internet terminal cache. The handle (*h* ) field identifies the data stream and relates the request with subsequent GW response packets. The 2-byte "width" field indicates the width of the pane, in pixels, in which the information will be displayed. THe GW_REFRESH command is shown in Table 10.

| | | | | | | |
|---|---|---|---|---|---|---|
| DLE | *len* | type | h | width | skip-len | creation date |

**TABLE 10**

The 2-byte "skip-len" field indicates how many data bytes must be skipped by the GW before sending the actual data. This is useful if a file was partially received and cached by the Internet terminal in a previous transmission, and does not need to be fully re-transmitted.

The 6-byte "creation date" field indicates the creation date of the currently cached document. This command packet is followed by one or more GW_DATA packets that include the anchor URL, and is terminated by a GW_EOF packet.

The GW responds with a GW_ANCHOR response. If the file in the cache is up-to-date, the AN_CACHE_VALIDITY field of the GW_ANCHOR header will indicate that the cache is up-to-date (CACHE_VALID). Otherwise, the AN_CONTENT field will be CACHE_REPLACE or CACHE_DONT, and the value of skip-len will be ignored and the entire file will be re-transmitted. The GW_ANCHOR response will be followed by zero or more appropriate GW_DATA packets, and terminated by a GW_EOF.

A GW_POST command is a form-request, transmitted via the HTTP POST method. The handle ( *h* ) field identifies the data stream and optionally relates the request with GW response packets. The GW responds with a GW_ANCHOR response, with a AN_CACHE_VALIDITY field of value CACHE_DONT, followed by GW_DATA packets. Responses to GW_POST are never cached. This command packet is followed by one or more GW_DATA packets that include the anchor URL and the posted text, and is terminated by a GW_EOF packet. The GW_POST command is given in Table 11.

| | | | | |
|---|---|---|---|---|
| DLE | *len* | type | h | width |

**TABLE 11**

The GW indicates its intention to send the requested GW_ANCHOR or GW-POST information by responding with a GW_ANCHOR response. A relatively long time may pass between the GW_ANCHOR or GW_POST command and the GW_ANCHOR response, due to network delays. The header information may include the creation data/time, content type, compression and display method. The GW_ANCHOR response is given in Table 12.

| | | | | |
|---|---|---|---|---|
| DLE | *len* | type | h | hdr info fields |

**TABLE 12**

The following anchor fields are defined:

| field | name | value length (bytes) |
|---|---|---|
| creation time-stamp | AN_CREATION | 4 (time_t) |
| cache validity | AN_CACHE VALIDITY | 1 |
| content type | AN_CONTENT | 1 |
| Ö. | | |

**TABLE 13**

The GW then follows this with a sequence of GW_DATA response packets, terminated by a GW_EOF response. (Also see GW_ACK, described below). if a file cannot be retrieved, or if there is an unreasonably long time-out, the Internet terminal will usually cancel the GW_ANCHOR request via a GW_ENDSTREAM command.

GW_DATA packets are used to send data streams, such as bitmap data, from the Internet terminal to the GW, or vice-versa. Each GW_DATA packet contains a handle that relates this packet to the specific stream. Data streams are terminated by a GW_EOF packet.

An informational percent byte, with a value between 1 and 100, indicates an estimated percentage of how much has been transmitted, including the package. A percent of 0% indicates that the sender does not know, or does not care to compute, the estimated percentage. The GW_DATA packet is given in Table 14.

| | | | | | |
|---|---|---|---|---|---|
| DLE | *len* | type | h | % | data... |

**TABLE 14**

The Internet terminal acknowledges each received data-packet of type GW_DATA by sending a GW_ACK command. This allows the GW to send another packet, without overflowing the Internet terminal input buffers, and prevents unwanted data from piling up in internal UNIX (host) serial driver and modem buffers. The Internet terminal may also, at regular time intervals, send GW_ACK commands to the GW to indicate that it is alive. GW_DATA packets sent by the Internet terminal to the GW are not acknowledged by the GW. The GW_ACK command is shown in Table 15.

| | | | |
|---|---|---|---|
| DLE | *len* | type | h |

**TABLE 15**

The GW_PRI command is provided to the GW to recommend the priority order for the transmission of packets of concurrent existing streams. The priority is provided in "pri," a one-byte non-negative value. The GW does not echo these commands. Initially, a stream is of priority ten. The GW_PRI command is given in Table 16.

| | | | | |
|---|---|---|---|---|
| DLE | *len* | type | h | *pri* |

**TABLE 16**

A priority of zero indicates that the stream is out of sight, This is usually true for images, when the user scrolls the screen. The GW sends data of all higher priority data streams first, in round-robin fashion, and only then sends data packets for lower priority streams. In the preferred embodiment of the invention, the values zero and ten only are used. However, alternative embodiments of the invention may use any appropriate priority values.

While the Web uses HTML coding for documents, the invention is also readily adapted for use with Internet access devices that require different document formats. In the preferred embodiment of the invention, the HTML layout is converted to an equivalent of the HTML layout. Alternative embodiments of the invention do not convert the HTML layout, or convert the HTML to different browser formats. For example, an HTML page can be converted into formats accessible by a Web telephone, a cellular phone, or a personal digital assistant having a wireless phone.

The layout conversion is performed, for example, by the server, client, Internet-capable telephone, Internet access device, or by a computer networked to the Internet-capable telephone or Internet access device. Further, such conversion may be an HTML-to-HTML conversion, for example as provided by a plug-in that operates in a connection with a conventional Web browser, such as Navigator, manufactured by Netscape Communications Corporation of Mountain View, California.

One embodiment of the invention is upgradeable via downloading from the Web. The HTML coding may thereby be readily modified to provide new features, update existing features, or to comply with different protocols. This HTML is then translated, as necessary.

The telephone numbers on a displayed Web page may be iconified and dialed, for example, as described in *Method And Apparatus For Iconifying And Automatically Dialing Telephone Numbers Which Appear On A Web Page*, also assigned to InfoGear Technology Corp. of Redwood City, CA, filed in the U.S. Patent and Trademark Office herewith and incorporated as a part hereof. These iconified telephone numbers may be added to an address book maintained as part of the invention.

Although the invention is described herein with reference to the preferred embodiment, one skilled in the art will readily appreciate that other applications may be substituted for those set forth herein without departing from the spirit and scope of the present invention.

For example, while the Preferred embodiment of the invention is adapted for use with a serial link, the teachings of the invention are readily applicable to any type of slow link.

Accordingly, the invention should only be limited by the Claims included below.

## CLAIMS

1. A method for accessing network information during a communications session, comprising the steps of:

accessing a host via a slow link using an Internet terminal;

the host negotiating an Internet connection on behalf of said Internet terminal with a software application integrated into said host; and

said software application using an interface protocol to transfer data from said Internet connection to and from said internet terminal, thereby mediating data transfer between the Internet and said Internet terminal.

2. The method of Claim 1, further comprising the step of said software application filtering said Internet data from said Internet connection to reduce the amount of data that is irrelevant to said Internet terminal's attributes.

3. The method of Claim 1, further comprising the step of said software application stripping redundant characters from said Internet data.

4. The method of Claim 1, further comprising the step of said software application converting said Internet data to a compressed equivalent data format.

5. The method of Claim 1, further comprising the steps of:

said software application using said interface protocol to make and negotiate multiple Internet requests, in parallel;

said software application parsing and forwarding said requests to an Internet server for execution;

said software application filtering data received from the Internet in response to said request and according to file type; and

said software application multiplexing said filtered data over said slow link to said Internet terminal.

6. The method of Claim 1, further comprising the steps of:

said Internet terminal storing a profile of a user of said Internet terminal; and

said software application using said profile to customize said Internet data sent to said internet terminal.

7. The method of Claim 1, further comprising the step of said software application using said interface protocol to upload data to upgrade said Internet terminal.

8. The method of Claim 1, wherein said software application is an off-line agent for said Internet terminal.

9. The method of Claim 1, further comprising the step of said software application caching information commonly used by said Internet terminal.

10. The method of Claim 1, further comprising the step of said software application tracking charges accruing to said Internet terminal as a result of said Internet connection.

11. The method of Claim 1, wherein said Internet terminal is an Internet-compatible telephone.

12. A method for accessing network information during a communications session, comprising the steps of:

accessing a host via a slow link using an Internet terminal;

a software application integrated into said host negotiating an Internet connection on behalf of said internet terminal;

said software application using an interface protocol to transfer data from said Internet connection to and from said Internet terminal;

said software application using said interface protocol to make and negotiate multiple Internet requests, in parallel;

said software application parsing and forwarding said requests to an Internet server for execution;

said software application filtering data received from the Internet in response to said request according to file type;

said software application reducing the amount of said Internet data that is irrelevant to said Internet terminal's attributes; and

said software application multiplexing said filtered data over said slow link to said Internet terminal.

13. The method of Claim 12, further comprising the steps of:

said Internet terminal storing a profile of a user of said Internet terminal; and

said software application using said profile to customize said Internet data sent to said Internet terminal.

14. The method of Claim 12, further comprising the step of said software application using said interface protocol to upload data to upgrade said Internet terminal.

15. The method of Claim 12, wherein said software application is an off-line agent for said Internet terminal.

16. The method of Claim 12, further comprising the step of said software application caching information commonly used by said Internet terminal.

17. The method of Claim 12, further comprising the step of said software application tracking charges accruing to said user of said Internet terminal as a result of said Internet connection.

18. The method of Claim 12, further comprising the step of said software application stripping redundant characters from said Internet data.

19. The method of Claim 12, further comprising the step of said software application converting said Internet data to a compressed equivalent data format.

20. The method of Claim 12, wherein said Internet terminal is an Internet-compatible telephone.

21. A system for accessing network information during a communications session, comprising:

an Internet terminal for accessing a host via a slow link;and

a software application integrated into said host for negotiating an Internet connection on behalf of said Internet terminal;

wherein said software application uses an interface protocol to transfer data from said Internet connection to and from said Internet terminal.

22. The system of Claim 21, further comprising a filtering module in said software application for filtering said Internet data from said Internet connection to strip out data that is irrelevant to said Internet appliance's attributes.

23. The system of Claim 21, further comprising a stripping module in said software application for stripping redundant characters from said Internet data.

24. The system of Claim 21, further comprising a compression module in said software application for converting said Internet data to a compressed equivalent data format.

25. The system of Claim 21, further comprising:

a parallel request module in said software application for using said interface protocol to make and negotiate multiple Internet requests, in parallel;

a parsing module in said software application for parsing and forwarding said requests to an Internet server for execution;

a file type module in said software application for filtering data received from the Internet in response to said request according to file type; and

a multiplexer module in said software application for multiplexing said filtered data over said slow link to said Internet terminal.

26. The system of Claim 21, further comprising:

a storage module in said Internet terminal for storing a profile of a user of said Internet terminal; and

a customizing module in said software application for using said profile to customize said Internet data sent to said Internet terminal.

27. The system of Claim 21, further comprising an upgrade module in said software application for using said interface protocol to upload data to upgrade said Internet terminal.

28. The system of Claim 21, wherein said software application is an off-line agent for said Internet terminal.

29. The system of Claim 21, further comprising a cache in said software application for caching information commonly used by said Internet terminal.

30. The system of Claim 21, further comprising a tracking module in said software application for tracking charges accruing to said client as a result of said Internet connection.

31. The system of Claim 21, further comprising a stripping module in said software application for stripping redundant characters from said Internet data.

32. The system of Claim 21, further comprising a compression module in said software application for converting said Internet data to a compressed equivalent data format.

33. The system of Claim 21, wherein said Internet terminal is an Internet-compatible telephone.

34. An access terminal, comprising:

an Internet-compatible telephone for receiving and displaying a Web page; and

a software module integrated into an Internet Service Provider for connecting said Internet-compatible telephone to the Internet;

wherein said software module mediates data transfer between the Internet and said Internet-compatible telephone.

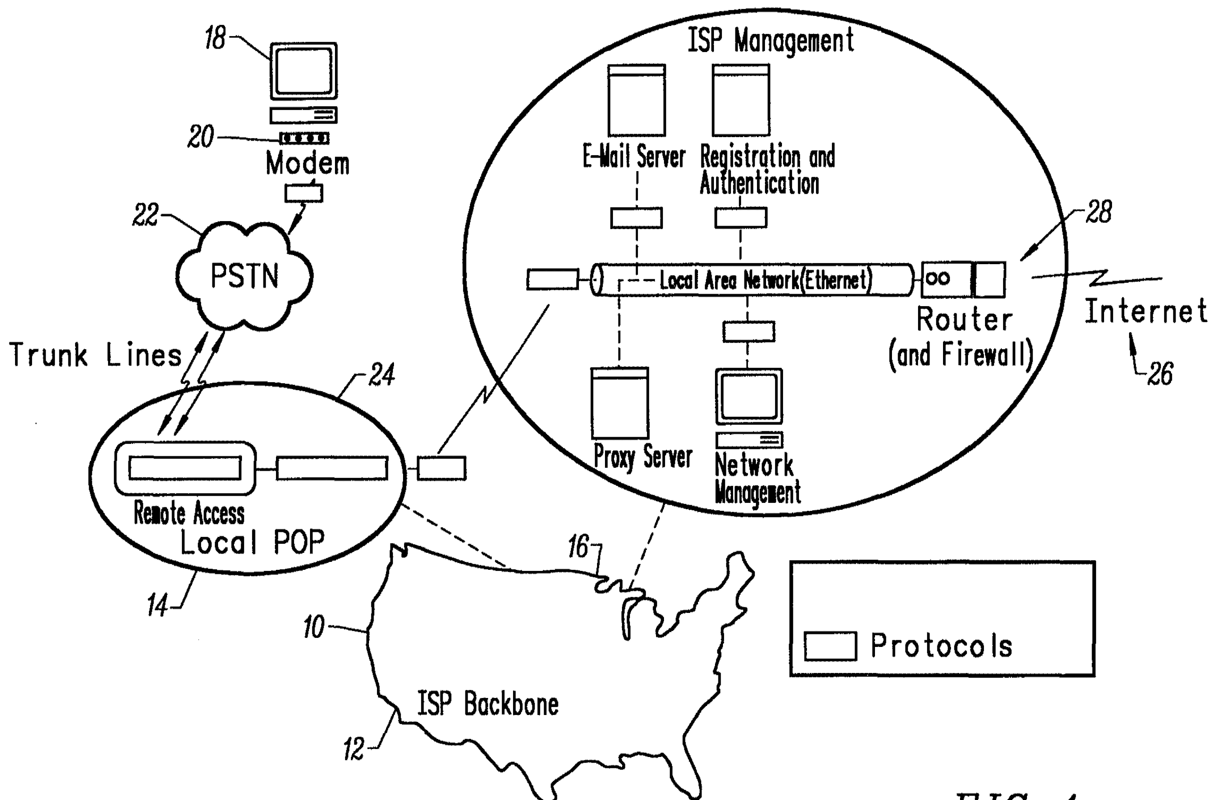


*FIG. 1*
*(PRIOR ART)*

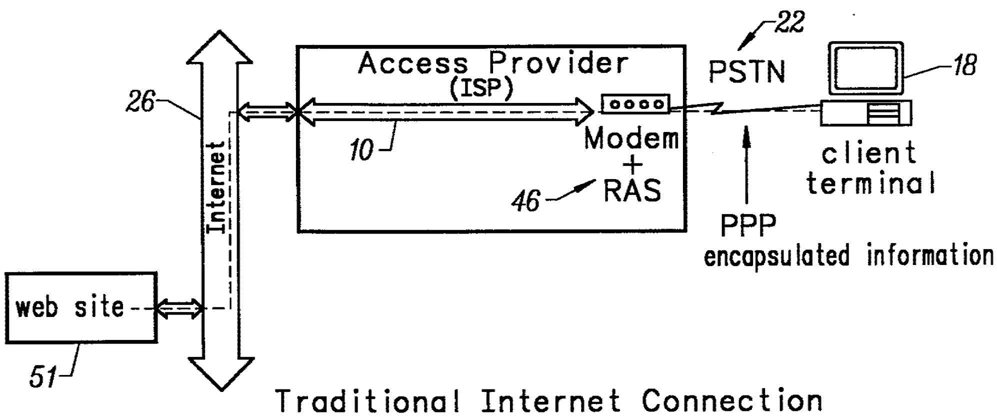


*FIG. 2*
*(PRIOR ART)*

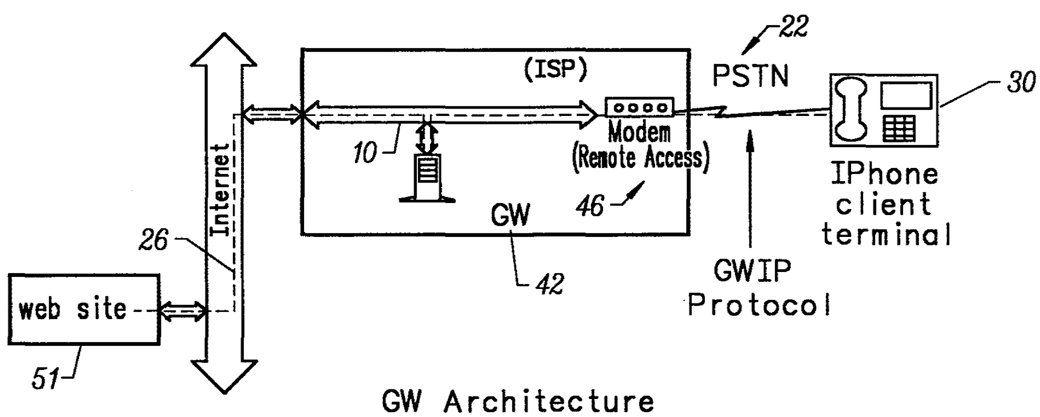
(ISP)
22
PSTN
30
Internet
10
Modem
(Remote Access)
46
GW
42
26
web site
51
IPhone
client
terminal
GWIP
Protocol
GW Architecture

*FIG. 3*

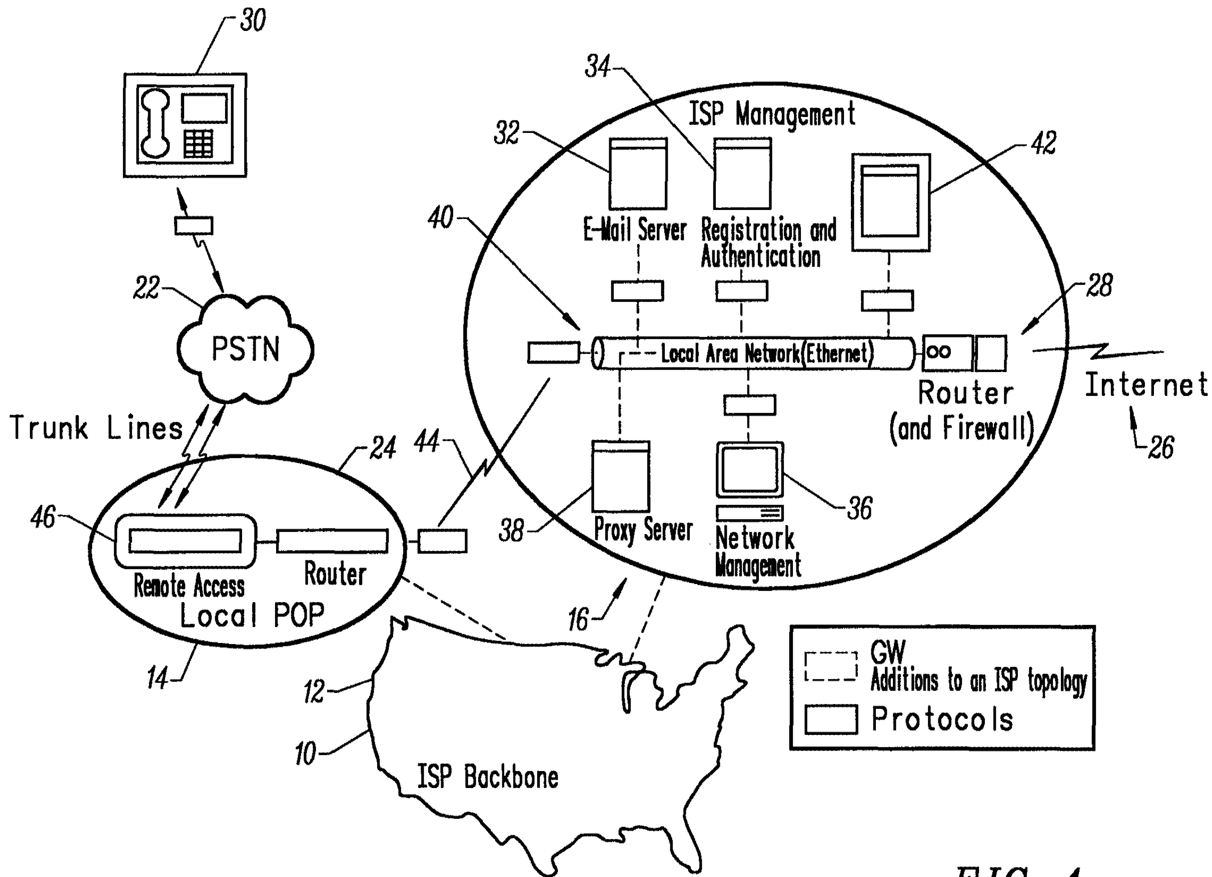
30
34
ISP Management
32
42
E-Mail Server
Registration and Authentication
40
22
28
PSTN
Local Area Network(Ethernet)
Router (and Firewall)
Internet
Trunk Lines
24
44
26
46
38
Proxy Server
36
Network Management
Remote Access
Router
Local POP
16
14
12
10
ISP Backbone
GW
Additions to an ISP topology
Protocols

*FIG. 4*

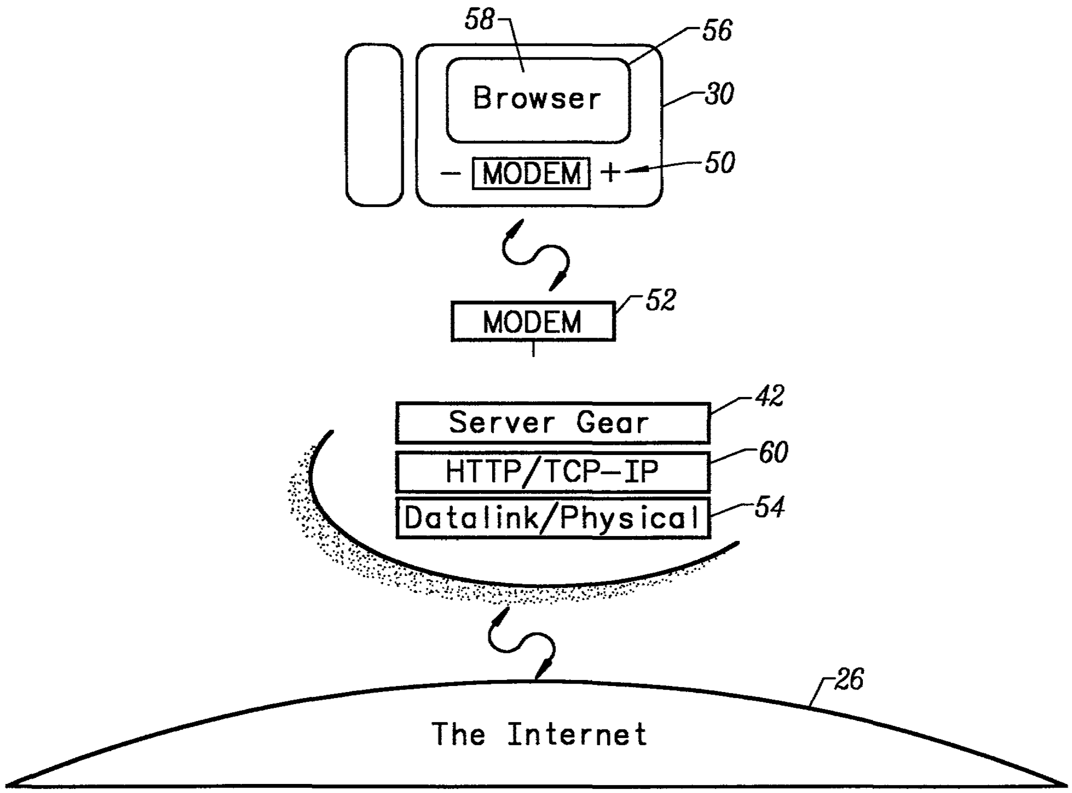
58
56
Browser
30
MODEM
50
MODEM
52
Server Gear
42
HTTP/TCP-IP
60
Datalink/Physical
54
26
The Internet

*FIG. 5*

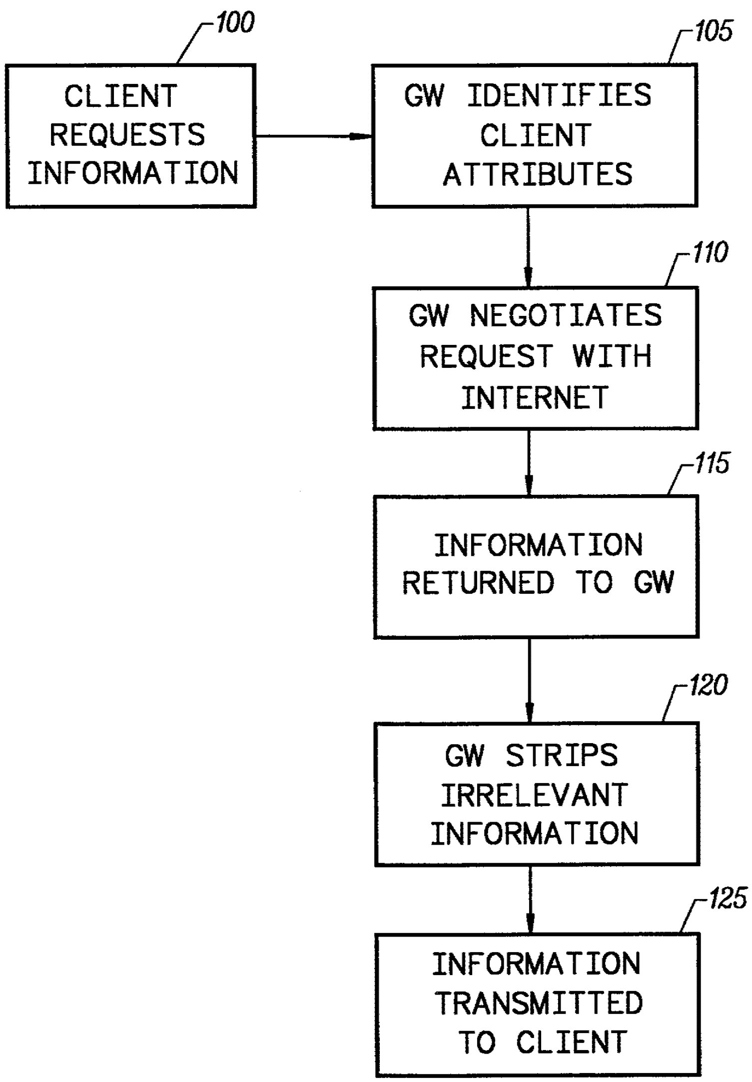
100
CLIENT REQUESTS INFORMATION
105
GW IDENTIFIES CLIENT ATTRIBUTES
110
GW NEGOTIATES REQUEST WITH INTERNET
115
INFORMATION RETURNED TO GW
120
GW STRIPS IRRELEVANT INFORMATION
125
INFORMATION TRANSMITTED TO CLIENT

*FIG. 6*

PCT

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(71) Applicant: INFOGEAR TECHNOLOGY CORPORATION [US/US]; Suite 200, 2055 Woodside Road, Redwood City, CA 94061 (US).

(72) Inventors: BENDELAC, Chaim; Yekutiel Adam Street 1b, 44282 Kfar-Saba (IL). BITTMAN, Ran, M.; Hakneset Hagdola Street 20, 62917 Tel Aviv (IL). SAMBURSKI, Kobi; Ig'al Alon Street 30b, 46324 Herzliya (IL).

(74) Agents: GLENN, Michael, A. et al.; Law Offices of Michael A. Glenn, P.O. Box 7831, Menlo Park, CA 94026 (US).

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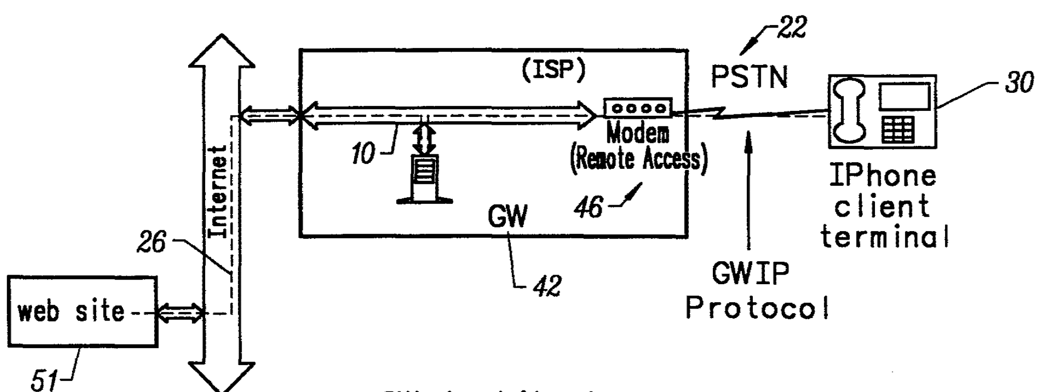


GW Architecture

(57) Abstract

A method and system are provided for transmitting information from a faster network to a data terminal via a slower network connection. The invention is adapted for use with any Internet access device or terminal, such as an Internet-compatible telephone. A client connects to the Internet via an intermediary software program, known as the Gateway (GW). In the preferred embodiment of the invention, the GW executes on a host computer of an ISP's Local Area Network (LAN). The GW thus mediates the data transfer between the Internet, such as the Web, and the client Internet terminal. The GW employs a point-to-point Internet protocol, the Gateway Interface Protocol (GWIP) to communicate with the client over the low-bandwidth link. The invention shifts the entire overhead of the Internet protocol stack to the GW, and does not involve the Internet terminal or the slow link between Internet terminal and GW. The GW makes and negotiates multiple Internet requests, in parallel, and multiplexes the resulting data streams, allowing documents to be loaded in parallel with their associated images. The GW may also be used to conveniently customize or upgrade the Internet terminal. The GW performs off-line services and caches commonly used information fetched from the Internet. The invention is also readily adapted for use with Internet access devices that require different document formats.

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# INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/19451

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04L29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br><br>Y | EP 0 797 342 A (SONY CORP) 24 September 1997<br><br>see abstract<br><br>see page 2, line 5 - page 3, line 28<br>see page 4, line 10 - page 5, line 1<br>see page 5, line 15-27<br>see page 6, line 36-50<br>see page 7, line 21 - page 8, line 18<br>see page 8, line 48 - page 9, line 46<br>see page 10, line 46 - page 11, line 16<br>see figures 1,4,5,7,8,13<br>---<br>-/-- | 1,2,11,<br>21,22,<br>33,34<br>3,4,23,<br>24,31,32 |

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 24 February 1999 | 23.07.99 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Lievens, K |

3

Form PCT/ISA/210 (second sheet) (July 1992)

# INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/19451

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US 4 971 407 A (HOFFMAN PHILIP M) 20 November 1990<br>see column 1, line 8 - column 5, line 52<br>see column 13, line 60 - column 14, line 14<br>--- | 3,4,23, 24,31,32 |
| X | AJAY BAKRE ET AL: "I-TCP: INDIRECT TCP FOR MOBILE HOSTS"<br>PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON DISTRIBUTED COMPUTIN SYSTEMS, VANCOUVER, MAY 30 - JUNE 2, 1995, no. CONF. 15, 30 May 1995, INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, pages 136-143, XP000530804<br>see abstract<br>see page 136, right-hand column, line 1-26<br>see page 137, left-hand column, line 17 - page 138, right-hand column, line 20<br>----- | 1,21 |

3

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 98/19451

**Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)**

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-4,11,21-24,31-33,34

**Remark on Protest**

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet (1)) (July 1998)

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

1. Claims: 1-4,11,21-24,31-33,34

   Method and system for compressing data.

2. Claims: 1,5,12-20,21,25

   Method and system for handling multiple Internet requests in parallel.

3. Claims: 1,6,21,26

   Method and system for storing a user profile for customising Internet data.

4. Claims: 1,7,21,27

   Method and system for upgrading the Internet terminal.

5. Claims: 1,8,21,28

   Method and system for off-line processing.

6. Claims: 1,9,21,29

   Method and apparatus for caching commonly used information.

7. Claims: 1,10,21,30

   Method and apparatus for keeping track of charges.

## INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 98/19451

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| EP 0797342 A | 24-09-1997 | CN 1172568 A | 04-02-1998 |
| | | WO 9714244 A | 17-04-1997 |
| US 4971407 A | 20-11-1990 | CA 2037044 A,C | 10-02-1991 |
| | | DE 69024629 D | 15-02-1996 |
| | | DE 69024629 T | 15-05-1996 |
| | | EP 0439569 A | 07-08-1991 |
| | | JP 4501349 T | 05-03-1992 |
| | | WO 9102412 A | 21-02-1991 |

Form PCT/ISA/210 (patent family annex) (July 1992)

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(21) International Application Number: PCT/US98/19451

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(30) Priority Data:
08/948,534 9 October 1997 (09.10.97) US

(71) Applicant: INFOGEAR TECHNOLOGY CORPORATION [US/US]; Suite 200, 2055 Woodside Road, Redwood City, CA 94061 (US).

(72) Inventors: BENDELAC, Chaim; Yekutiel Adam Street 1b, 44282 Kfar-Saba (IL). BITTMAN, Ran, M.; Hakneset Hagdola Street 20, 62917 Tel Aviv (IL). SAMBURSKI, Kobi; Ig'al Alon Street 30b, 46324 Herzliya (IL).

(74) Agents: GLENN, Michael, A. et al.; Law Offices of Michael A. Glenn, P.O. Box 7831, Menlo Park, CA 94026 (US).

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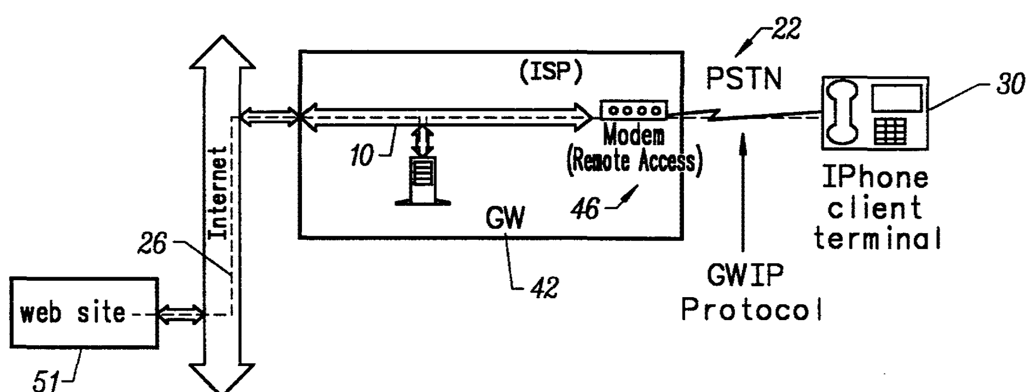


GW Architecture

(57) Abstract

A method and system are provided for transmitting information from a faster network to a data terminal via a slower network connection. The invention is adapted for use with any Internet access device or terminal, such as an Internet–compatible telephone. A client connects to the Internet via an intermediary software program, known as the Gateway (GW). In the preferred embodiment of the invention, the GW executes on a host computer of an ISP's Local Area Network (LAN). The GW thus mediates the data transfer between the Internet, such as the Web, and the client Internet terminal. The GW employs a point–to–point Internet protocol, the Gateway Interface Protocol (GWIP) to communicate with the client over the low–bandwidth link. The invention shifts the entire overhead of the Internet protocol stack to the GW, and does not involve the Internet terminal or the slow link between Internet terminal and GW. The GW makes and negotiates multiple Internet requests, in parallel, and multiplexes the resulting data streams, allowing documents to be loaded in parallel with their associated images. The GW may also be used to conveniently customize or upgrade the Internet terminal. The GW performs off–line services and caches commonly used information fetched from the Internet. The invention is also readily adapted for use with Internet access devices that require different document formats.

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## AMENDED CLAIMS

[received by the International Bureau on 24 August 1999 (24.08.99);
original claims 1-34 replaced by amended claims 1-25 (4 pages)]

1. A method for accessing network information during a communications session, comprising the steps of:

accessing a host via a slow link using an Internet terminal;

the host negotiating an Internet connection on behalf of said Internet terminal with a software application integrated into said host;

said software application using an interface protocol to transfer data from said Internet connection to and from said internet terminal, thereby mediating data transfer between the Internet and said Internet terminal;

said software application filtering said Internet data from said Internet connection to reduce the amount of data that is irrelevant to said Internet terminal's attributes;

said software application stripping redundant characters from said Internet data; and

said software application converting said Internet data to a compressed equivalent data format.

2. The method of Claim 1, further comprising the steps of:

said software application using said interface protocol to make and negotiate multiple Internet requests, in parallel;

said software application parsing and forwarding said requests to an Internet server for execution;

said software application filtering data received from the Internet in response to said request and according to file type; and

said software application multiplexing said filtered data over said slow link to said Internet terminal.

3. The method of Claim 1, further comprising the steps of:

said Internet terminal storing a profile of a user of said Internet terminal; and

said software application using said profile to customize said Internet data sent to said internet terminal.

4. The method of Claim 1, further comprising the step of said software application using said interface protocol to upload data to upgrade said Internet terminal.

5. The method of Claim 1, wherein said software application is an off-line agent for said Internet terminal.

6. The method of Claim 1, further comprising the step of said software application caching information commonly used by said Internet terminal.

7. The method of Claim 1, further comprising the step of said software application tracking charges accruing to said Internet terminal as a result of said Internet connection.

8. The method of Claim 1, wherein said Internet terminal is an Internet-compatible telephone.

9. A method for accessing network information during a communications session, comprising the steps of:

accessing a host via a slow link using an Internet terminal;

a software application integrated into said host negotiating an Internet connection on behalf of said internet terminal;

said software application using an interface protocol to transfer data from said Internet connection to and from said Internet terminal;

said software application using said interface protocol to make and negotiate multiple Internet requests, in parallel;

said software application parsing and forwarding said requests to an Internet server for execution;

said software application filtering data received from the Internet in response to said request according to file type;

said software application reducing the amount of said Internet data that is irrelevant to said Internet terminal's attributes;

said software application multiplexing said filtered data over said slow link to said Internet terminal;

said software application stripping redundant characters from said Internet data; and

said software application converting said Internet data to a compressed equivalent data format.

10. The method of Claim 9, further comprising the steps of:

said Internet terminal storing a profile of a user of said Internet terminal; and

said software application using said profile to customize said Internet data sent to said Internet terminal.



AMENDED SHEET (ARTICLE 19)

11. The meth of Claim 9, further comprising the step of s software application using said interface protocol to upload data to upgrade said Internet terminal.

12. The method of Claim 9, wherein said software application is an off-line agent for said Internet terminal.

13. The method of Claim 9, further comprising the step of said software application caching information commonly used by said Internet terminal.

14. The method of Claim 9, further comprising the step of said software application tracking charges accruing to said user of said Internet terminal as a result of said Internet connection.

15. The method of Claim 9, wherein said Internet terminal is an Internet-compatible telephone.

16. A system for accessing network information during a communications session, comprising:

an Internet terminal for accessing a host via a slow link;and

a software application integrated into said host for negotiating an Internet connection on behalf of said Internet terminal;

wherein said software application uses an interface protocol to transfer data from said Internet connection to and from said Internet terminal;

a stripping module in said software application for stripping redundant characters from said Internet data; and

a compression module in said software application for converting said Internet data to a compressed equivalent data format.

17. The system of Claim 16, further comprising a filtering module in said software application for filtering said Internet data from said Internet connection to strip out data that is irrelevant to said Internet appliance's attributes.

18. The system of Claim 16, further comprising:

a parallel request module in said software application for using said interface protocol to make and negotiate multiple Internet requests, in parallel;

a parsing module in said software application for parsing and forwarding said requests to an Internet server for execution;

a file typ nodule in said software application for filt. ing data received from the Internet in response to said request according to file type; and

a multiplexer module in said software application for multiplexing said filtered data over said slow link to said Internet terminal.

19. The system of Claim 16, further comprising:

a storage module in said Internet terminal for storing a profile of a user of said Internet terminal; and

a customizing module in said software application for using said profile to customize said Internet data sent to said Internet terminal.

20. The system of Claim 16, further comprising an upgrade module in said software application for using said interface protocol to upload data to upgrade said Internet terminal.

21. The system of Claim 16, wherein said software application is an off-line agent for said Internet terminal.

22. The system of Claim 16, further comprising a cache in said software application for caching information commonly used by said Internet terminal.

23. The system of Claim 16, further comprising a tracking module in said software application for tracking charges accruing to said client as a result of said Internet connection.

24. The system of Claim 16, wherein said Internet terminal is an Internet-compatible telephone.

25. An access terminal, comprising:

an Internet-compatible telephone for receiving and displaying a Web page;

a software application integrated into an Internet Service Provider for connecting said Internet-compatible telephone to the Internet;

wherein said software application mediates data transfer between the Internet and said Internet-compatible telephone;

a stripping module in said software application for stripping redundant characters from said Internet data; and

a compression module in said software application for converting said Internet data to a compressed equivalent data format.